Water-Quality Assessment of the Ozark Plateaus Study Unit, Arkansas, Kansas, Missouri, and Oklahoma—Habitat Data and Characteristics at Selected Sites, 1993–95

U.S. GEOLOGICAL SURVEY

Open-File Report 97–236

Contribution from the
National Water-Quality Assessment Program

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By Suzanne R. Femmer

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Rolla, Missouri
1997

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FOREWORD

The mission of the U.S. Geological Survey (USGS) is to assess the quantity and quality of the earth resources of the Nation and to provide information that will assist resource managers and policymakers at Federal, State, and local levels in making sound decisions. Assessment of water-quality conditions and trends is an important part of this overall mission.

One of the greatest challenges faced by water-resources scientists is acquiring reliable information that will guide the use and protection of the Nation's water resources. That challenge is being addressed by Federal, State, interstate, and local water-resource agencies and by many academic institutions. These organizations are collecting water-quality data for a host of purposes that include: compliance with permits and water-supply standards; development of remediation plans for a specific contamination problem; operational decisions on industrial, wastewater, or water-supply facilities; and research on factors that affect water quality. An additional need for water-quality information is to provide a basis on which regional and national-level policy decisions can be based. Wise decisions must be based on sound information. As a society we need to know whether certain types of water-quality problems are isolated or ubiquitous, whether there are significant differences in conditions among regions, whether the conditions are changing over time, and why these conditions change from place to place and over time. The information can be used to help determine the efficacy of existing water-quality policies and to help analysts determine the need for and likely consequences of new policies.

To address these needs, the Congress appropriated funds in 1986 for the USGS to begin a pilot program in seven project areas to develop and refine the National Water-Quality Assessment (NAWQA) Program. In 1991, the USGS began full implementation of the program. The NAWQA Program builds upon an existing base of water-quality studies of the USGS, as well as those of other Federal, State, and local agencies. The objectives of the NAWQA Program are to:

- Describe current water-quality conditions for a large part of the Nation's freshwater streams, rivers, and aquifers.
- Describe how water quality is changing over time.
- Improve understanding of the primary natural and human factors that affect water-quality conditions.

This information will help support the development and evaluation of management, regulatory, and monitoring decisions by other Federal, State, and local agencies to protect, use, and enhance water resources.

The goals of the NAWQA Program are being achieved through investigations of 60 of the Nation's most important river basins and aquifer systems, which are referred to as study units. These study units are distributed throughout the Nation and cover a diversity of hydrogeologic settings. More than two-thirds of the Nation's freshwater use occurs within the 60 study units and more than two-thirds of the people served by public water-supply systems live within their boundaries.

National synthesis of data analysis, based on aggregation of comparable information obtained from the study units, is a major component of the program. This effort focuses on selected water-quality topics using nationally consistent information. Comparative studies will explain differences and similarities in observed water-quality conditions among study areas and will identify changes and trends and their causes. The first topics addressed by the national synthesis are pesticides, nutrients, volatile organic compounds, and aquatic biology. Discussions on these and other water-quality topics will be published in periodic summaries of the quality of the Nation's ground and surface water as the information becomes available.

This report is an element of the comprehensive body of information developed as part of the NAWQA Program. The program depends heavily on the advice, cooperation, and information from many Federal, State, interstate, Tribal, and local agencies and the public. The assistance and suggestions of all are greatly appreciated.

Robert M. Hirsch
Chief Hydrologist

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Water-Quality Assessment of the Ozark Plateaus Study Unit, Arkansas, Kansas, Missouri, and Oklahoma—Habitat Data and Characteristics at Selected Sites, 1993–95

By Suzanne R. Femmer

ABSTRACT

The characterization of instream and riparian habitat is part of the multiple lines of evidence used by the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program to assess the water quality of streams. In the NAWQA Program, integrated physical, chemical, and biological assessments are used to describe water-quality conditions. The instream and riparian habitat data are collected at sites selected for surface-water chemistry analyses and biological assessment.

Instream and riparian habitat data are structured in a nested scheme—at sampling reach, segment, and basin scales. The habitat data were collected in the Ozark Plateaus study unit at 41 sites during 1993–95. Thirteen of these sites, representative of selected combinations of physiography, land use, and basin size, have longitudinal, transverse, and quarter point vegetation plot surveys in addition to the Level I survey measurements (reach length, depth, velocity, dominant substrate, embeddedness, and vegetation quarter points, for example) recommended by the NAWQA Program protocols. These habitat data were from onsite measurements, U.S. Geological Survey topographic maps, and a geographic information system.

The analyses of the habitat data indicates substantial differences between sites of differing physiography and basin-scale land-use activities. The basins range from 46.4 to 4,318 square kilometers and have stream orders from 2 to 6. All streams studied are a riffle/pool type, and most have cobble that is less than 50 percent embedded as the dominant streambed substrate.

Of the three physiographic sections studied, the Boston Mountains have the largest mean segment and sideslope gradients, basin relief, woody species diversity, and stream depths when compared with sites of similar size. Channel sinuosities, mean velocities, and canopy angles are largest at sites in the Springfield Plateau physiographic section. The sites in the Salem Plateau physiographic section have the largest woody vegetation densities and mean channel widths.

Sites in basins with predominantly agricultural land use tend to have more open canopies, steeper segment gradients, and more sinuous stream channels than the forested sites. Sites in predominantly forested basins tend to have deeper and swifter flow, smaller channel widths, and more dense woody riparian vegetation (at small basins) than the agricultural sites.

INTRODUCTION

The physical characteristics of streams and basins vary with differing geology, land use, and climate. Although various combinations of these

attributes give each water body its uniqueness, these factors can be used to characterize and classify streams and basins into similar groups for further study. These characterizations are essential, in conjunction with water and sediment chemistry and biology, to provide multiple lines of evidence toward the evaluation of general stream quality.

In 1991, the U.S. Geological Survey (USGS) began full implementation of the National Water-Quality Assessment (NAWQA) Program to provide a consistent description of current water-quality conditions, to define long-term trends, and to identify, describe, and explain the major factors that affect water quality for a large part of the Nation's surface- and ground-water resources. When fully implemented, the NAWQA Program will include 60 study units, which incorporate parts of most major river basins and aquifer systems in the United States. The study units range from less than 2,590 km^2 (square kilometers) to more than 155,000 km^2 and include about 60 to 70 percent of the Nation's water use and population served by public water-supply systems.

The Ozark Plateaus study unit was among the first 20 NAWQA Program study units selected for investigation. The initial phase of the Ozark Plateaus study began in 1991 and continued through 1996. Intensive water-quality and biological investigations, conducted for 3 years (1993–95), are to be followed by 5 to 6 years of low-intensity monitoring, with the cycle perpetually repeated.

One objective of the Ozark Plateaus study is to design and implement a sampling network to describe the current status and temporal and spatial patterns of water quality and aquatic communities and to enable the development of hypotheses about the possible causes of observed patterns. The biological sampling network consists of reconnaissance of suitable sampling sites, bed sediment and tissue contaminant survey, ecological surveys, multi-reach assessment, and synoptic studies.

Thirteen sites were selected for intensive monitoring as a result of reconnaissance (fig. 1; table 1). These sites are called fixed sites. The sites were selected in small (79.0 to 150 km^2) and large (761 to 2,484 km^2) size basins with near-homogenous land uses (indicator sites) and one basin (1,365 km^2) that integrates several major land uses and physiographic sections. These 13 fixed sites are monitored continuously for stream discharge. Monthly and high-flow water-column samples were collected and analyzed for major ions, trace elements, nutrients, organic carbon, and physical properties, such as suspended sediment concentration (Reed and others, 1994, 1995; Hauck and others, 1996).

Synoptic sites were selected to improve the spatial coverage and to assess that the fixed sites are representative of the physiography and land-use type in their respective basins. A habitat survey was conducted once at each of the 28 non-gaged synoptic sites.

Fixed site and synoptic ecological surveys have been designed to assess the occurrence and distribution of aquatic communities, instream and riparian habitat, and contaminants detected in bed sediments and tissue. These surveys focus on ecological studies of community structure and function and on habitat characteristics to assess water quality.

Stream habitat documentation is an integral component of the ecological survey. Habitat assessment provides baseline information on environmental settings so that changes resulting from natural and anthropogenic actions can be identified, estimated, or predicted. Habitat assessment also can assist in the identification of limiting physical and chemical factors critical to biological communities.

This report presents summarized habitat data from the ecological surveys. The report describes the study unit and the methods used to collect the data. Data from 41 fixed and synoptic sites are presented in tables and maps and are briefly described.

Description of the Ozark Plateaus Study Unit

The Ozark Plateaus study unit is approximately 124,320 km^2 and includes parts of northern Arkansas, southeastern Kansas, southern Missouri, and northeastern Oklahoma. Eighty-three percent of the study unit area is in the Ozark Plateaus Province—Salem Plateau, Springfield Plateau, Boston Mountains, and St. Francois Mountains physiographic sections; 14 percent is in the Central Lowland Province–Osage Plains physiographic section; and 3 percent is in the Coastal Plain Province–Mississippi Alluvial Plain physiographic section (fig. 1).

These provinces correspond closely with the four largest ecoregions (fig. 2) of the study unit—Ozark Highlands, Boston Mountains, Central Irregular Plains, and the Mississippi Alluvial Plain. Ecoregions are regions of greatest homogeneity of geology, natural

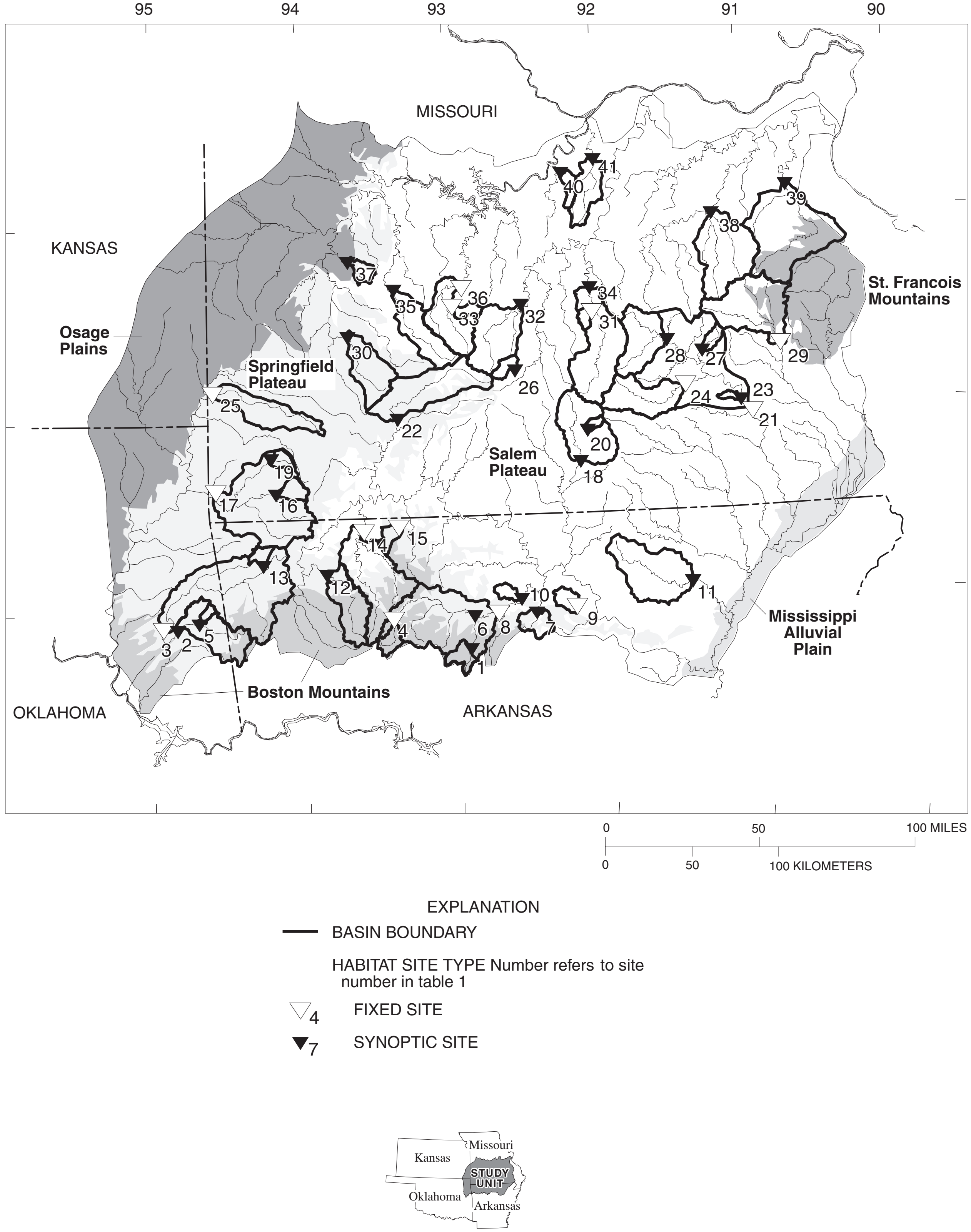

Figure 1. Physiographic sections and location of sites with habitat data in the Ozark Plateaus study unit, 1993-95.

Table 1. Characteristics of sites with habitat data in the Ozark Plateaus study unit

[SYN, synoptic site; Boston, Boston Mountains; Springfield, Springfield Plateau; FS, fixed site; Salem, Salem Plateau]

Site number (fig. 1)	Site name	Station number	Latitude	Longitude	Site type	Major physiographic section	Major basin land use
1	Richland Creek near Witts Springs, Ark.	07055875	354749	0925543	SYN	Boston	Forest
2	Baron Fork at Eldon, Okla.	07197000	355516	0945018	SYN	Springfield	Agriculture
3	Illinois River near Tahlequah, Okla.	07196500	355522	0945524	FS	Springfield	Agriculture
4	Buffalo River near Boxley, Ark.	07055646	355643	0932412	FS	Boston	Forest
5	Peacheater Creek at Christie, Okla.	07196973	355717	0944146	SYN	Springfield	Agriculture
6	Buffalo River near Eula, Ark.	07055865	355811	0925310	SYN	Boston and Springfield[1]	Forest
7	Big Creek near Big Flat, Ark.	07057100	355843	0922853	SYN	Springfield	Forest
8	Buffalo River near St. Joe, Ark.	07056000	355902	0924444	FS	Boston and Springfield[1]	Forest
9	North Sylamore Creek near Fifty Six, Ark.	07060710	355943	0921245	FS	Springfield	Forest
10	Water Creek near Evening Star, Ark.	07056695	360259	0923434	SYN	Springfield	Forest
11	Strawberry River near Poughkeepsie, Ark.	07074000	360637	0912659	SYN	Salem	Forest
12	War Eagle Creek near Hindsville, Ark.	07049000	361202	0935120	SYN	Springfield	Agriculture
13	Little Osage Creek at Healing Springs, Ark.	07194947	361513	0941612	SYN	Springfield	Agriculture
14	Kings River near Berryville, Ark.	07050500	362536	0933715	FS	Springfield, Salem, and Boston	Mixed
15	Yocum Creek near Oak Grove, Ark.	07053250	362714	0932123	FS	Springfield	Agriculture
16	Mikes Creek at Powell, Mo.	07188660	363735	0941052	SYN	Springfield	Forest
17	Elk River near Tiff City, Mo.	07189000	363750	0943512	FS	Springfield	Agriculture
18	North Fork White River near Dora, Mo.	07057470	364535	0920912	SYN	Salem	Forest
19	North Fork Indian Creek near Wanda, Mo.	07188855	364840	0941236	SYN	Springfield	Agriculture
20	Noblett Creek near Willow Springs, Mo.	07057420	365516	0920544	SYN	Salem	Forest
21	Current River at Van Buren, Mo.	07067000	365929	0910053	SYN	Salem	Forest
22	James River near Boaz, Mo.	07052250	370025	0932150	SYN	Springfield	Urban/Agriculture[2]

Table 1. Characteristics of sites with habitat data in the Ozark Plateaus study unit—Continued

Site number (fig. 1)	Site name	Station number	Latitude	Longitude	Site type	Major physiographic section	Major basin land use
23	Rogers Creek near Van Buren, Mo.	07066650	370257	0910418	SYN	Salem	Forest
24	Jacks Fork above Alley Spring, Mo.	07065495	370830	0912730	FS	Salem	Forest
25	Center Creek near Smithfield, Mo.	07186480	370920	0943610	FS	Springfield	Mining/Urban/ Agriculture[3]
26	Woods Fork Gasconade River near Hartville, Mo.	06927590	371443	0923404	SYN	Salem	Agriculture
27	Big Creek at Mauser Mill, Mo.	07065040	371847	0911900	SYN	Salem	Forest
28	Current River below Akers, Mo.	07064535	372235	0913251	SYN	Salem	Forest
29	Black River near Lesterville, Mo.	07061400	372626	0904957	FS	Salem	Forest/Mining[4]
30	Sac River near Dadeville, Mo.	06918440	372635	0934105	SYN	Springfield	Agriculture
31	Paddy Creek above Slabtown Spring, Mo.	06929315	373329	0920255	FS	Salem	Forest
32	Osage Fork near Russ, Mo.	06927780	373518	0923054	SYN	Salem	Agriculture
33	Dousinbury Creek near Wall Street, Mo.	06923150	373540	0925800	FS	Salem	Agriculture
34	Big Piney River near Big Piney, Mo.	06930000	373958	0920302	SYN	Salem	Forest
35	Pomme de Terre River near Polk, Mo.	06921070	374056	0932212	SYN	Salem	Agriculture
36	Niangua River at Windyville, Mo.	06923250	374103	0925527	FS	Salem	Agriculture
37	Brush Creek above Collins, Mo.	06919925	375005	0934022	SYN	Salem	Agriculture
38	Huzzah Creek near Scotia, Mo.	07014300	380144	0911248	SYN	Salem	Forest/Mining[4]
39	Big River near Richwoods, Mo.	07018100	380934	0904222	SYN	Salem	Forest/Mining[4]
40	Little Tavern Creek near St. Elizabeth, Mo.	06926250	381608	0921250	SYN	Salem	Agriculture
41	Maries River near Freeburg, Mo.	06926900	382001	0915934	SYN	Salem	Agriculture

[1]Although this site is in both physiographic sections, for this report the site will be listed in the Springfield Plateau physiographic section.
[2]The land use in the James River Basin is about 10 percent urban.
[3]The Center Creek Basin is about 3 percent urban and lead-zinc mining occurs in the basin.
[4]Substantial amount of lead-zinc mining occurs in the basin.

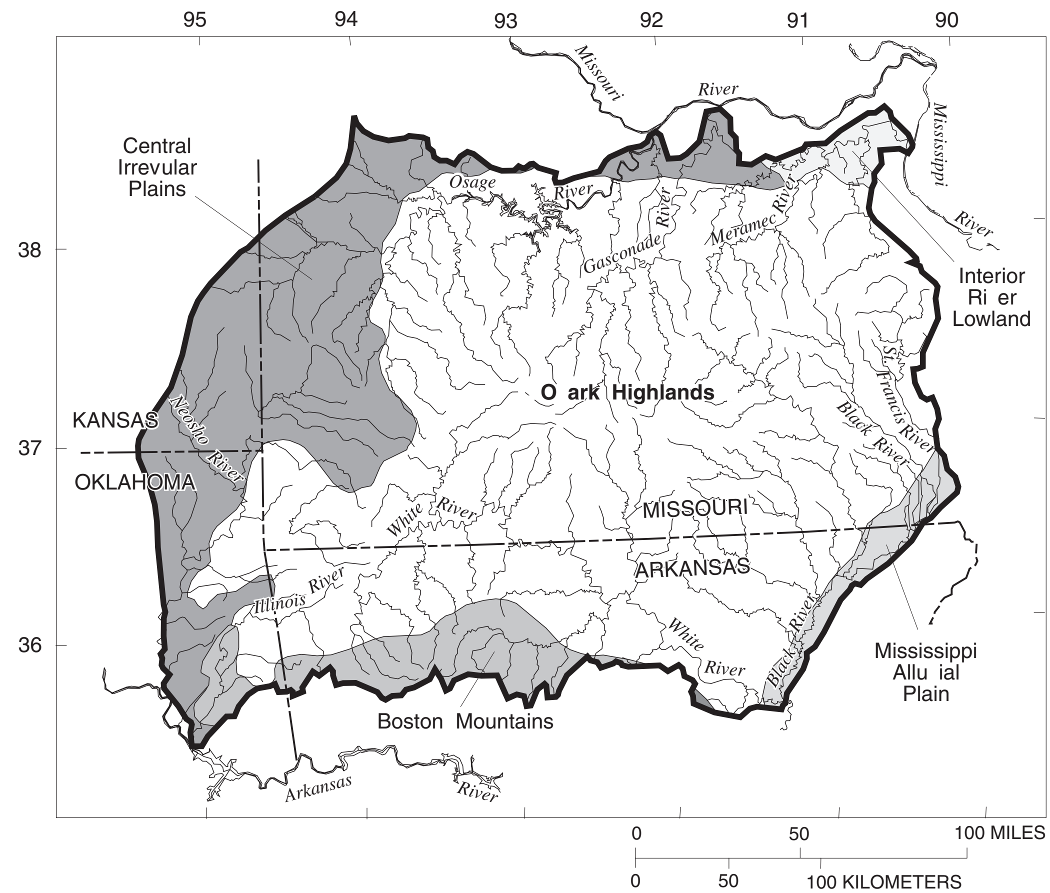

Figure 2. Ecoregions and major river systems of the Ozark Plateaus study unit.

vegetation, soil type, and land use. These features also are important in describing habitat and biological communities. Surface geology and stream gradient are major factors in distinguishing these ecoregions (Omernik and Gallant, 1987).

The Salem and Springfield Plateaus and the St. Francois Mountains physiographic sections are in the Ozark Highlands ecoregion. The topography of the Ozark Highlands ecoregion ranges from the gently rolling hills of the Springfield Plateau physiographic section to the sharp relief of the Salem Plateau physiographic section (Fenneman, 1938) with elevations ranging from 91 to 518 m (meters). Local relief often exceeds 91 m along major streams. The streams of the Ozark Highlands ecoregion typically are clear, high gradient, riffle and pool type with coarse gravel, cobble, boulder, and bedrock substrate of limestone, dolostone, and chert. Base flows are maintained during the dry season by springs. The Ozark Highlands ecoregion is the richest and diverse faunal ecoregion of the Ozark Plateaus study unit. In Missouri alone, more than 56 species and sub-species of fish, 20 species of crayfish, and 23 species of mussels are largely restricted to the Ozark Highlands ecoregion. Fish populations of the smaller streams of the Ozark Highlands ecoregion are dominated by the minnow and perch families, and the larger streams are dominated by the sucker and sunfish families. Fish species diversity and richness increase as the stream gradient decreases and the stream size increases. Common aquatic plants are the water willow, coontail, pondweed, eel grass, and water star grass (Pflieger, 1989).

The Boston Mountains physiographic section corresponds to the Boston Mountains ecoregion and is extremely rugged with steep, incised valleys and narrow divides. The elevation ranges from 366 to 701 m with local relief as much as 305 m. The streams are clear, high gradient, riffle and pool type with gravel, cobble, boulder, and bedrock substrate of sandstone, shale, and limestone. There is little surface flow in the

dry season because there are few springs in the Boston Mountains. The lack of water and instream cover are the main reasons for the restricted species diversification. Fish populations of the streams are dominated by the perch and minnow families, followed by the sunfish, sucker, and catfish families. Similar to the Ozark Highlands ecoregion, the species diversity and richness increase with the decrease in stream gradient and increase in stream size. Aquatic plants are uncommon in this ecoregion (Arkansas Department of Pollution Control and Ecology, 1987).

The Osage Plains physiographic section generally corresponds with the Central Irregular Plains ecoregion. The topography of the Osage Plains physiographic section is slightly sloping hills and broad valleys with elevations from 244 to 305 m and relief rarely greater than 76 m. The streams have high alluvial banks, turbid water, long pools, poorly defined riffles with silt, sand, and bedrock substrates of shale, sandstone, and limestone. The streams have intermittent or low base flows because of the lack of large spring flows. The Central Irregular Plains ecoregion is the least diverse faunal ecoregion of the study unit. Small streams are dominated by the minnow and sunfish species, the larger streams by the catfish and sucker species. Unlike the other ecoregions, species diversity and richness only slightly increase as the stream size increases. Aquatic plants are uncommon in the Central Irregular Plains ecoregion (Pflieger, 1989).

The Mississippi Alluvial Plain physiographic section generally corresponds with the Mississippi Alluvial Plain ecoregion. The topography is a level plane with elevations of 61 to 91 m and minimal local relief. The streams are straight with long pools, poorly defined riffles, and high alluvial banks. The streambed substrate is clay, sand, and small gravel of unconsolidated sediments of Cretaceous through Quaternary age and organic material. The streams have consistent flow because of the holding capacity of the alluvial material of the lowlands, which slowly releases water into the streams and drainage ditches during the dry season. The fish species of the Mississippi Alluvial Plain ecoregion are not as diverse as those in the Ozark Highlands ecoregion, but are distinctive. The small streams are dominated by the minnows and darters (perch family), the larger streams by the gizzard shad and catfish species. No dominant large fish species have been noted in this ecoregion. Abundant aquatic plants include coontail, pondweed, and milfoil (Pflieger, 1989).

The Ozark Plateaus study unit is drained by seven major river systems—the White, Neosho-Illinois, Osage, Gasconade, Meramec, Black, and St. Francis Rivers. The White (and its tributary the Black River), Osage, Gasconade, Meramec, and St. Francis Rivers flow into the Missouri-Mississippi Rivers system. The Neosho and Illinois Rivers are tributaries of the Arkansas River, which also flows into the Mississippi River (fig. 2).

Land use in the study unit primarily is forest and agriculture—range, rowcrops, and confined animal operations. Range and rowcrops generally are located in the northwestern part of the study area, forest and rangeland in the eastern and southern part, and poultry and dairy cattle operations in the southwestern part of the study unit. Lead-zinc mining occurs near the St. Francois Mountains along the northeastern part of the study unit and has occurred historically in the Tri-State area near the Kansas, Missouri, and Oklahoma borders (Adamski and others, 1994).

The 1990 population within the study unit was approximately 2.3 million people, a 28 percent increase from 1970, with growth predominantly occurring in northwestern Arkansas and southwestern Missouri. Springfield, Missouri, is the largest city in the study unit with a population of about 140,000. Joplin, Missouri, and Fayetteville, Rogers, and Springdale, Arkansas, are the only other cities within the study unit with populations exceeding 20,000 residents (Adamski and others, 1994).

The study unit has a temperate climate with average annual precipitation ranging from about 96.5 cm (centimeters) in the north to 121.9 cm in the south. Mean annual temperature ranges from 13.3 °C (degrees Celsius) in the northeast to 15.6 °C in the southwest (Adamski and others, 1994).

METHODS

Natural and anthropogenic features in the basin affect the physical aspects of streams along their entire length. When a specific site is studied, the upstream character must be considered. For these reasons, habitat data were collected at various spatial scales—basin, segment, reach, and microhabitat—at each of the 13 fixed sites. The recommended data for the Level I and Level II analyses for the NAWQA Program were collected from the fixed sites—this consists of the basin, segment, and reach scale of the site, including pebble counts and longitudinal and transverse surveys at the

reach scale. Modified habitat evaluations were made at 28 synoptic sites in the Ozark Plateaus study unit (fig. 1; table 1). These typically were non-gaged sites where a one-time sampling collection was made to assess the representativeness of the fixed sites within a specific land use and physiographic section. A modified set of Level I data was collected on the reach scale; bank data were omitted at the synoptic sites with the exception of the quarter point vegetation data. The habitat data were collected in the manner indicated for the NAWQA Program (Meador and others, 1993).

The basin is defined in this report as the entire basin area upstream from the sampling site. The basin data generally were compiled from USGS topographic maps and from data stored within a geographic information system (GIS). Information such as basin area, land use and cover, basin texture, stream length, stream order (Strahler, 1952), and basin relief were compiled from these sources. Basin texture is an expression of the spacing of stream channels upstream from the reference location. Stream length is the measure of the stream from the headwaters to the downstream end of the sampling reach or the reference location, or both. Basin relief is the highest elevation in the basin minus the elevation of the site.

The segment scale is the length of the stream bounded by tributary junctions or a disruptive feature, such as a point-source discharge or a water fall immediately upstream from a sampling site (Frissell and others, 1986). The segment data were assembled from 7.5 minute USGS topographic maps. These data include site elevation, segment gradient, sideslope gradient, and channel sinuosity (the ratio of the channel distance to the straight line downvalley distance). Segment gradient is the change in slope from the upstream edge of the segment to the reference point. Sideslope gradient is the mean of the change in elevation at three transects of the segment within 400 m of the stream channel.

A stream or sampling reach scale is defined by the average stream channel width. The length generally is equal to 20 wetted channel widths, with a minimum length of 150 m and a maximum of 1,000 m. Generally, the reach location was selected to capture at least two repeating geomorphic units such as two riffles and two pools. All sites in the study unit were a pool/riffle type. Reach data were collected at the site at a low-flow stage and at a minimum of six transects. The reach diagrams presented in this report are generalized to approximate surveyed transect and location of stream features (for example, gravel bars). Data included mean wetted channel width, bank width, water depth and velocity, dominant streambed substrate and embeddedness, canopy angle, channel aspect (direction of downstream flow), vegetation quarter points (Mueller-Dombois and Ellenberg, 1974), and Wolman pebble counts (Wolman, 1954). The dominant bed substrate is the spatially dominant substrate at the six transects sampled. The mean pebble class was determined by Wolman pebble counts at the transects. The canopy angle was determined from the midpoint of the channel at each transect. The horizontal angle from the line of sight of the investigator to the tallest feature on each bank was summed and then subtracted from 180 degrees, resulting in the canopy angle. Some values are presented as modal, which is the most frequently occurring value of that particular characteristic.

Vegetation quarter points were established at each end of the 6 transects for a total of 12 quarter points per reach. Quadrants were established at each point and the distance to the nearest tree or shrub (minimum of 2 m high and 3 cm diameter at breast height) was measured. The diameter at breast height was measured, and the species was recorded. Theoretically, the mean area per plant in which a single plant occurs is equal to the mean distance between plants squared (Cottam and Curtis, 1956). The total density is the total number of individuals of all species per unit area—100 m^2 (square meters) in this report.

Microhabitats are described as snags, macrophytes, or streambed substrates within a sampling reach. Characterizations of these microhabitats were documented mainly during algal and invertebrate sampling efforts and are not included in this report (Meador and others, 1993).

HABITAT DATA AT SELECTED SITES

Data from 41 sites have been categorized by physiographic section, then by major land use, and thirdly by basin size. Land use is sorted by major land use in the basin (table 1) except for a few sites where a land-use activity in a small percentage of the basin (such as mining) can have a substantial effect downstream. Classification of agricultural land use includes row crops, pasture, and confined animal operations. Basin areas less than 300 km^2 were considered small; basin areas larger than 500 km^2 were considered large for this report.

Within each category, the range of basin sizes will be listed with the dominant streambed substrate at the sites. The mean pebble class will be listed for the fixed sites. Mean channel width, mean canopy angles, and vegetation of the sites will be described. The data presented in this section are reach scale.

Salem Plateau Physiographic Section

The Salem Plateau physiographic section comprises about 53 percent of the Ozark Plateaus study unit (fig. 1) and has elevations that range from about 70 to 520 m. The topography is dissected by a dendroidal network of streams resulting in rugged relief that can range from 15 to 240 m (Adamski and others, 1994).

Forested Land Use—Large Basins

Basin areas of the sites range from 761 to 4,318 km^2 (table 2). The dominant streambed substrate at these sites is cobble with a modal embeddedness of 6 to 25 percent. The mean pebble class is in the coarse gravel to very coarse gravel range. Mean wetted channel width ranges from 23.2 to 41.7 m, with the exception of the Current River at Van Buren site, which has the largest basin area and the largest mean channel width of 97.0 m. The mean canopy angles range from 63 to 115 degrees. Stream channels with large canopy angles are well exposed to sunlight. The mean quarter point to plant distances are larger and the total density smaller at sites on the Jacks Fork, Big Piney, and Strawberry Rivers than at other sites. During visits to these sites, pasturelands were observed in the riparian corridor (for example, fig. 3).

Forested Land Use—Small Basins

Basin areas of the sites range from 46.4 to 108 km^2 (table 3). The dominant streambed substrate is cobble with embeddedness ranging from 6 to 75 percent. The mean pebble class at the Paddy Creek site (fig. 4) is very coarse gravel. The mean wetted channel width ranges from 6.4 to 20.3 m. The canopy angles range from 31 to 83 degrees, which results in a shaded stream channel. The mean quarter point to plant distances range from 1.94 to 3.48 m. The mean quarter point area per plant ranges from 3.76 to 12.14 m^2. Although the Noblett Creek site has less dense vegetation than the other sites, it has high woody plant species richness.

Agricultural Land Use—Large Basins

Basin areas of the sites range from 482 to 909 km^2 (table 4). There is not an obvious dominant streambed substrate type for this type of site although the substrate present is mostly only 6 to 25 percent embedded. The mean pebble class is very coarse gravel at the Niangua River site (fig. 5). The mean wetted channel width ranges from 18.1 to 60.8 m, and sites have a fairly open canopy that ranges from 50 to 125 degrees. The mean quarter point to plant distance ranges from 2.28 to 3.91 m, and the mean quarter point area per plant ranges from 5.18 to 15.29 m^2. Total density ranges from 6.54 to 19.3 individuals per 100 m^2. Species richness values of woody plants are similar at each site. Sites in this class were observed to have wooded riparian zones along the sampling reach. However, the Osage Fork site data are not similar to the other sites in this class. The Osage Fork site has smaller streambed substrate, a wider channel, larger canopy angle, and greater total woody vegetation density than the other sites.

Agricultural Land Use—Small Basins

Basin areas of the sites range from 106 to 143 km^2 (table 5). The modal dominant streambed substrate ranges from sand/gravel to bedrock with embeddedness ranging from 6 to 50 percent. The mean pebble class at the Dousinbury Creek site is very coarse gravel. The mean wetted channel width of the sites ranges from 4.9 to 23.6 m. Mean canopy angles range from 58 to 135 degrees. The mean quarter point to plant distances range from 2.04 to 4.10 m, and the mean quarter point area per plant range from 4.16 to 16.83 m^2. Based on the quarter point vegetation data, the Woods Fork Gasconade River site has the most open riparian zone of this category. All sites have pasture located at points along the riparian area in the sampling reach. Dousinbury Creek (fig. 6) flows through an active dairy operation with only about one-sixth of the riparian zone along the sampling reach that was wooded.

Table 2. Habitat data for forested sites in large drainage basins in the Salem Plateau physiographic section

[km^2, square kilometers; m, meters; m/sec, meter per second; mm, millimeters; m^2, square meters; FS, fixed site; SYN, synoptic site; N/A, data not available]

Site name	Site number (fig. 1)	Site type	Basin area (km^2)	Land use percentage		Reach length (m)	Mean depth (m)	Mean velocity (m/sec)	Modal dominant substrate	Modal embeddedness (percent)	Mean pebble class (mm)
				Forest	Agriculture						
Jacks Fork above Alley Spring, Mo.	24	FS	790	78	22	557	0.294	0.144	Cobble	6–25	Coarse gravel (29)
Strawberry River near Poughkeepsie, Ark.	11	SYN	1,225	57	41	825	.318	.816	Gravel	6–25	N/A
North Fork White River near Dora, Mo.	18	SYN	1,046	71	29	558	.450	.417	Cobble	6–25	N/A
Current River at Van Buren, Mo.	21	SYN	4,318	82	17	849	1.332	.724	Cobble	26–50	Very coarse gravel (45)
Current River below Akers, Mo.	28	SYN	761	74	26	260	.444	.717	Cobble	51–75	N/A
Big Piney River near Big Piney, Mo.	34	SYN	1,427	64	36	517	.637	.391	Gravel	26–50	N/A

Site name	Site number (fig. 1)	Mean wetted channel width (m)	Mean bank width (m)	Mean canopy angle (degrees)	Riparian quarter point vegetation (woody)			
					Mean point to plant distance (m)	Mean area per plant (m^2)	Total density (individuals per 100 m^2)	Number of species
Jacks Fork above Alley Spring, Mo.	24	23.7	2.1	115	3.84	14.77	6.78	12
Strawberry River near Poughkeepsie, Ark.	11	25.2	N/A	95	6.30	39.75	2.52	9
North Fork White River near Dora, Mo.	18	23.2	N/A	63	2.86	8.16	12.25	12
Current River at Van Buren, Mo.	21	97.0	2.7	110	2.49	6.71	14.90	12
Current River below Akers, Mo.	28	35.3	N/A	102	2.74	7.51	13.31	10
Big Piney River near Big Piney, Mo.	34	41.7	N/A	97	3.40	11.54	8.66	14

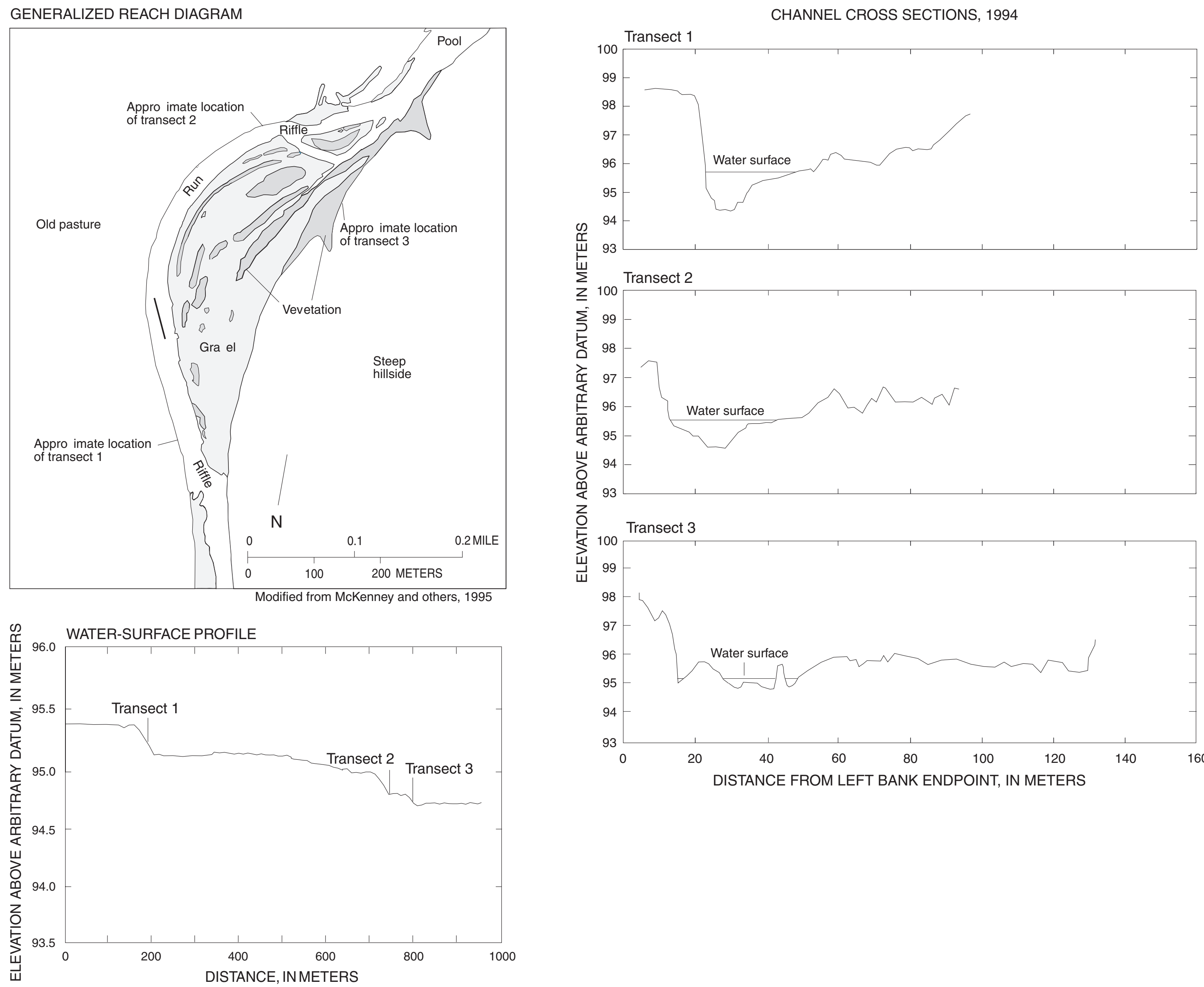

Figure 3. Generalized reach diagram, water-surface profile, and channel cross sections of the Jacks Fork above Alley Spring, Missouri (station number 07065495).

Table 3. Habitat data for forested sites in small drainage basins in the Salem Plateau physiographic section

[km^2, square kilometers; m, meters; m/sec, meter per second; mm, millimeters; m^2, square meters; FS, fixed site; SYN, synoptic site; N/A, data not available]

Site name	Site number (fig. 1)	Site type	Basin area (km^2)	Land use percentage		Reach length (m)	Mean depth (m)	Mean velocity (m/sec)	Modal dominant substrate	Modal embeddedness (percent)	Mean pebble class (mm)
				Forest	Agriculture						
Paddy Creek above Slabtown Spring, Mo.	31	FS	88.6	90	10	193	0.382	0.070	Cobble	26–50	Very coarse gravel (38)
Noblett Creek near Willow Springs, Mo.	20	SYN	53.4	91	9	208	.262	.243	Cobble	26–50	N/A
Rogers Creek near Van Buren, Mo.	23	SYN	46.4	99	1	225	.106	.185	Gravel	51–75	N/A
Big Creek at Mauser Mill, Mo.	27	SYN	108	64	36	224	.297	.206	Gravel/ Cobble	6–25	N/A

Site name	Site number (fig. 1)	Mean wetted channel width (m)	Mean bank width (m)	Mean canopy angle (degrees)	Riparian quarter point vegetation (woody)			
					Mean point to plant distance (m)	Mean area per plant (m^2)	Total density (individuals per 100 m^2)	Number of species
Paddy Creek above Slabtown Spring, Mo.	31	7.3	0.9	45	N/A	N/A	23.20	9
Noblett Creek near Willow Springs, Mo.	20	14.3	N/A	31	3.48	12.14	8.23	13
Rogers Creek near Van Buren, Mo.	23	6.4	N/A	46	2.16	4.69	21.34	14
Big Creek at Mauser Mill, Mo.	27	20.3	N/A	83	1.94	3.76	26.61	9

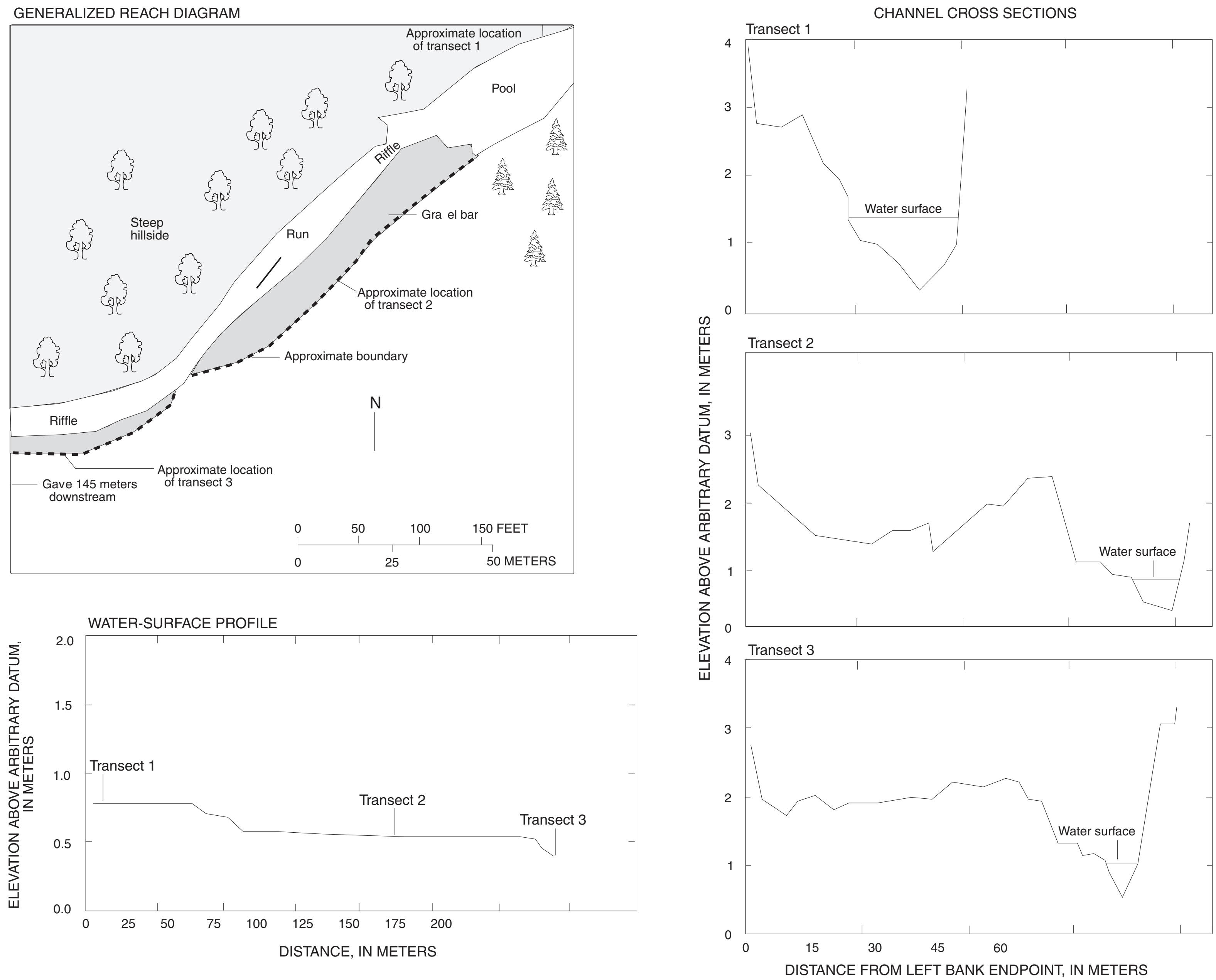

Figure 4. Generalized reach diagram, water-surface profile, and channel cross sections of Paddy Creek above Slabtown Spring, Missouri (station number 06929315).

Table 4. Habitat data for agricultural sites in large drainage basins in the Salem Plateau physiographic section

[km^2, square kilometers; m, meters; m/sec, meter per second; mm, millimeters; m^2, square meters; FS, fixed site; SYN, synoptic site; N/A, data not available]

Site name	Site number (fig. 1)	Site type	Basin area (km^2)	Land use percentage		Reach length (m)	Mean depth (m)	Mean velocity (m/sec)	Modal dominant substrate	Modal embeddedness (percent)	Mean pebble class (mm)
				Forest	Agriculture						
Niangua River at Windyville, Mo.	36	FS	875	42	56	295	0.606	0.550	Cobble	6–25	Very coarse gravel (44)
Osage Fork near Russ, Mo.	32	SYN	909	48	52	240	.439	.187	Sand/ Gravel	6–25	N/A
Pomme de Terre River near Polk, Mo.	35	SYN	715	28	72	258	.299	.172	Bedrock/ Cobble	6–25	N/A
Maries River near Freeburg, Mo.[1]	41	SYN	482	59	41	308	.291	.238	Cobble	51–75	N/A

Site name	Site number (fig. 1)	Mean wetted channel width (m)	Mean bank width (m)	Mean canopy angle (degrees)	Riparian quarter point vegetation (woody)			
					Mean point to plant distance (m)	Mean area per plant (m^2)	Total density (individuals per 100 m^2)	Number of species
Niangua River at Windyville, Mo.	36	21.9	3.7	98	3.04	9.26	10.8	11
Osage Fork near Russ, Mo.	32	60.8	N/A	125	2.28	5.18	19.3	11
Pomme de Terre River near Polk, Mo.	35	18.1	N/A	50	3.91	15.29	6.54	12
Maries River near Freeburg, Mo.	41	31.3	N/A	97	3.49	12.16	8.22	10

[1]Although the basin is greater than 50 percent forested, agricultural effects are apparent in the water quality of the site (J.V. Davis, U.S. Geological Survey, oral commun., 1996).

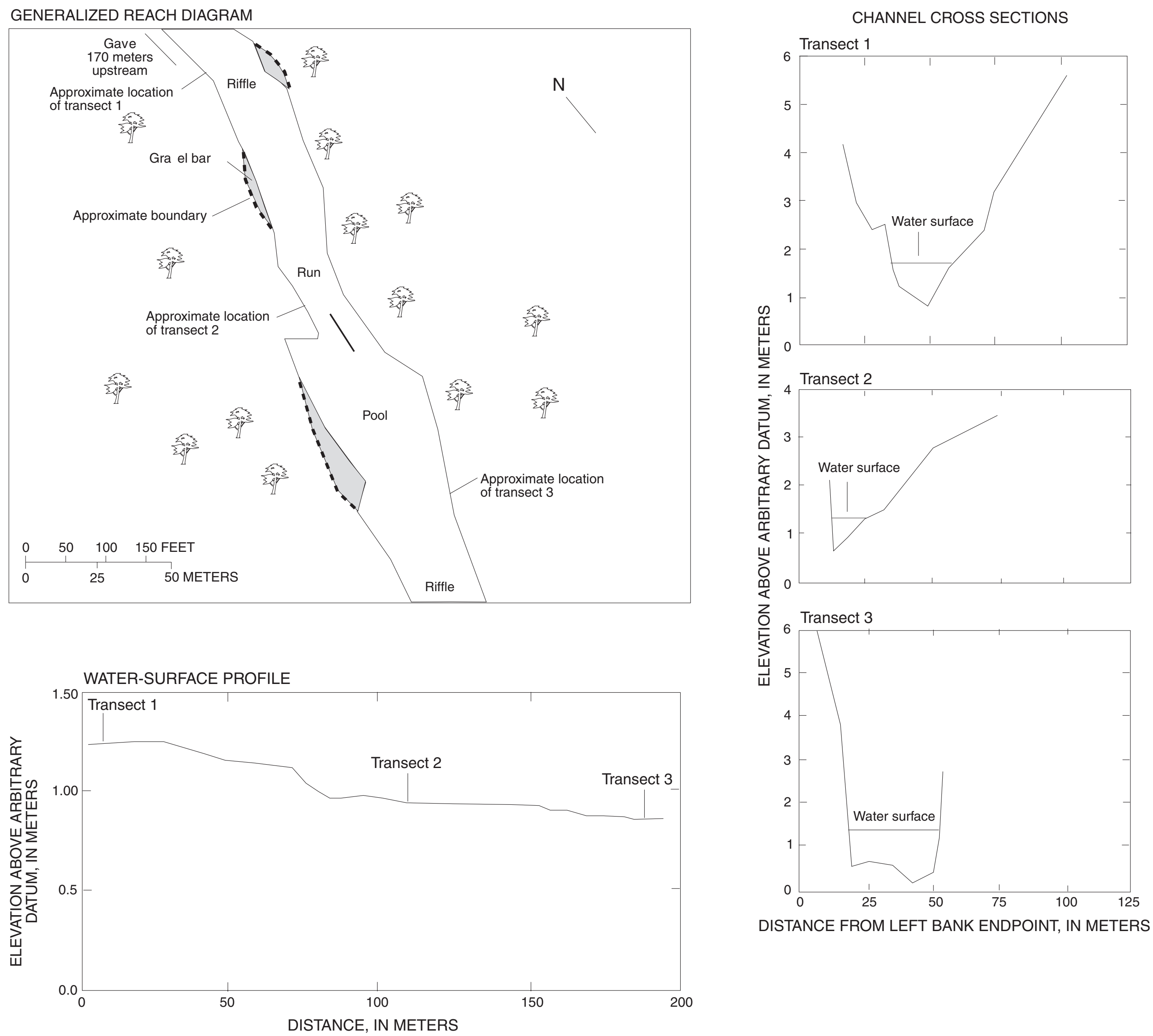

Figure 5. Generalized reach diagram, water-surface profile, and channel cross sections of the Niangua River at Windyville, Missouri (station number 06923250).

Table 5. Habitat data for agricultural sites in small drainage basins in the Salem Plateau physiographic section

[km^2, square kilometers; m, meters; m/sec, meter per second; mm, millimeters; m^2, square meters; FS, fixed site; SYN, synoptic site; N/A, data not available]

Site name	Site number (fig. 1)	Site type	Basin area (km^2)	Land use percentage		Reach length (m)	Mean depth (m)	Mean velocity (m/sec)	Modal dominant substrate	Modal embeddedness (percent)	Mean pebble class (mm)
				Forest	Agriculture						
Dousinbury Creek near Wall Street, Mo.	33	FS	106	40	60	303	0.524	0.174	Bedrock	26–50	Very coarse gravel (44)
Woods Fork Gasconade River near Hartville, Mo.	26	SYN	118	43	57	240	.224	.169	Cobble	6–25	N/A
Brush Creek above Collins, Mo.	37	SYN	143	37	62	173	.281	.059	Cobble	6–25	N/A
Little Tavern Creek near St. Elizabeth, Mo.	40	SYN	124	50	50	217	.438	.146	Sand/ Gravel	6–25	N/A

Site name	Site number (fig. 1)	Mean wetted channel width (m)	Mean bank width (m)	Mean canopy angle (degrees)	Riparian quarter point vegetation (woody)			
					Mean point to plant distance (m)	Mean area per plant (m^2)	Total density (individuals per 100 m^2)	Number of species
Dousinbury Creek near Wall Street, Mo.	33	23.6	2.7	135	2.04	4.16	6.40	7
Woods Fork Gasconade River near Hartville, Mo.	26	20.3	N/A	87	4.10	16.83	5.94	8
Brush Creek above Collins, Mo.	37	4.9	N/A	58	3.10	9.59	10.42	10
Little Tavern Creek near St. Elizabeth, Mo.	40	11.1	N/A	113	2.82	7.98	12.54	12

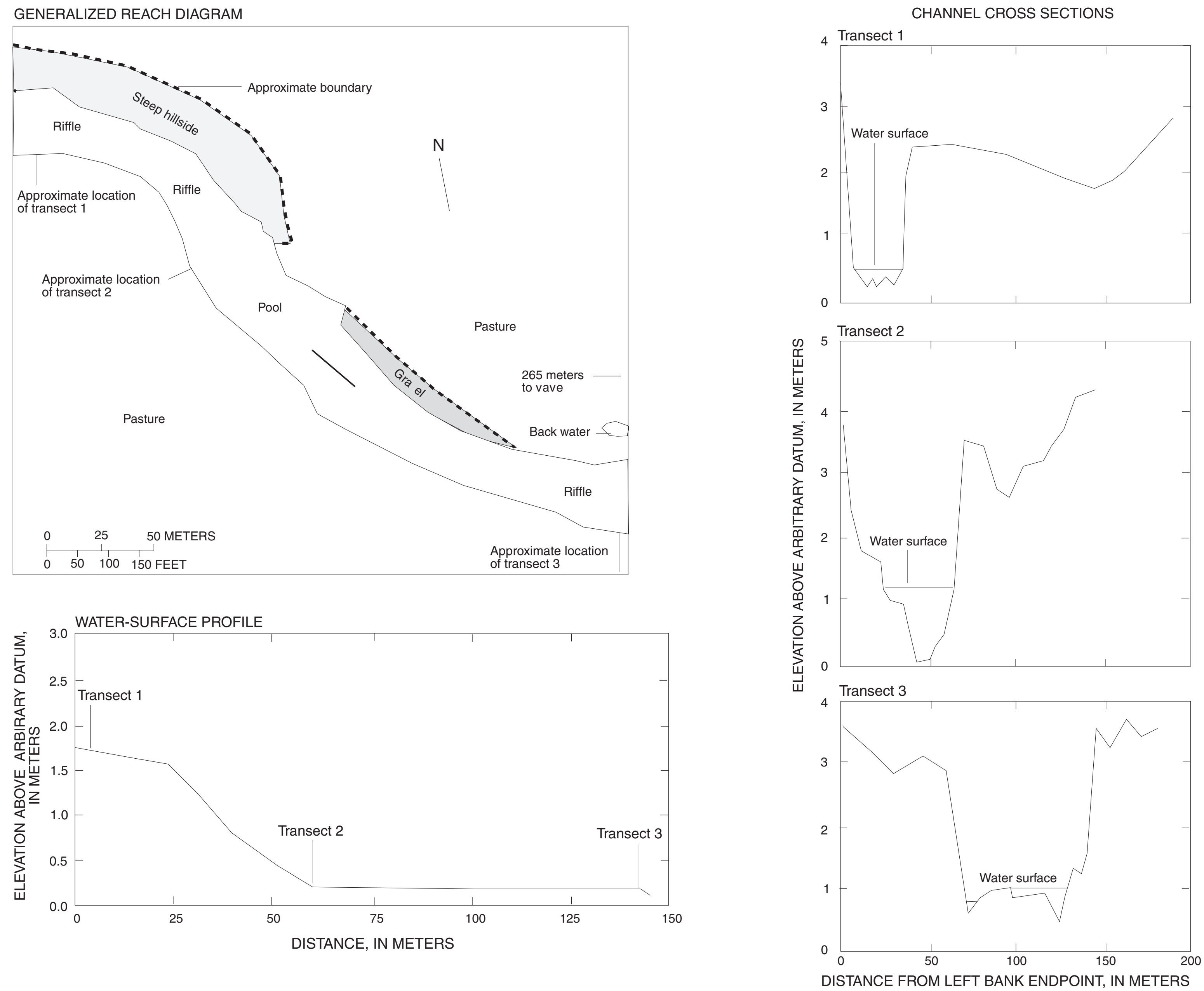

Figure 6. Generalized reach diagram, water-surface profile, and channel cross sections of Dousinbury Creek near Wall Street, Missouri (station number 06923150).

Forested and Mining Land Uses—Large Basins

Basin areas of these sites range from 1,242 to 1,904 km^2 (table 6). The modal dominant streambed substrate is a cobble and gravel mix with modal embeddedness ranging from 6 to 25 percent with the exception of the Big River site, which has embeddedness ranging from 51 to 75 percent. The mean pebble class at the Black River site is very coarse gravel. The mean wetted channel widths of the sites range from 23.2 to 48.8 m. The mean canopy angles range from 77 to 111 degrees resulting in an open stream channel. The mean quarter point to plant distances are similar among these sites, ranging from 3.81 to 4.31 m. The mean quarter point area per plant and the total density ranges are also similar among the forested and mining land-use sites. All sites have a wooded riparian corridor, although the Big River site has overgrown pasture and a high vertical silt bank at the right edge of water. The Black River site has an extremely large gravel bar and overflow channel on the left side of the channel and the stream is contained by a steep hillside on the right bank (fig. 7). Although the Black River site has a pool and riffle type geomorphology, the dominant stream feature in the sampling reach is a large run. The Huzzah Creek and the Big River sites both have dominant gravel bars on the left side of the stream channel.

Comparison of Fixed Site Characteristics by Basin Size and Land Use

Within large and small basins with forested land use, the small basin site tends to have steeper sideslope gradients and smaller sinuosities (straighter channels) than the large basin sites (table 7). The large basin sites generally have swifter mean velocity, larger mean channel widths, and larger canopy angles than the small basin site. Both the large and the small forested sites have similar pebble classes and embeddedness. Based on the quarter point vegetation data, the large basin sites have smaller total woody plant densities, but similar woody plant species richness in comparison with the small basin site.

For large and small basin sites with agricultural land use, the small basin site has a steeper segment gradient, but a smaller sideslope gradient than the larger site. The large basin site has a larger sinuosity, deeper and swifter mean flow, and wider banks than the smaller basin site. The sites have similar substrates, embeddedness, and canopy angles. The large basin site has more dense and diverse woody vegetation than the small basin site based on the quarter point vegetation data.

Agricultural sites have greater segment gradients, sinuosities, bank widths, and canopy angles (especially between the small basins) than the forested sites. The forested sites tend to have larger sideslope gradients, streambed substrate embeddedness, depths, and velocities. The agricultural and forested sites have similar streambed substrate. The forested sites generally have greater total woody plant densities and species richness than the agricultural sites.

Mixed land-use sites (forest and mining—large basins) did not have many differences when compared to the forested sites with the exception of embeddedness and segment gradient, which were more similar to the large basin agricultural sites. The mixed land- use sites generally have larger bank widths and smaller total woody plant densities than the other two types of sites.

Springfield Plateau Physiographic Section

The Springfield Plateau physiographic section is mostly gently rolling hills that overlie about 21 percent of the Ozark Plateaus study unit and has elevations ranging from 305 to 518 m. The topography rarely has relief exceeding 60 to 90 m (Adamski and others, 1994).

Forested Land Use—Large Basins

Basin areas of the two sites studied were 1,562 and 2,147 km^2 (table 8). At both sites, the dominant streambed substrate is cobble with an embeddedness of 6 to 25 percent. The mean pebble class at the Buffalo River near St. Joe site is coarse gravel [32 mm (millimeters)]. The mean wetted channel widths of this class were 14.2 and 24.6 m. Canopy angles were 106 and 148 degrees leaving the channel open to sunlight. The quarter point vegetation data are extremely different between these sites. The vegetation at the Buffalo River near Eula site is less dense than the vegetation at the St. Joe site. The mean quarter point to plant distance at the St. Joe site is 6.02 m, whereas the mean quarter point to plant distance at the Eula site is 16.02 m. The mean quarter point area per plant is 36.27 m^2 at the St. Joe site and 256.72 m^2 at the Eula site. The St. Joe site has a high bluff on the right side

Table 6. Habitat data for sites in forested basins that include mining land use in the Salem Plateau physiographic section

[km^2, square kilometers; m, meters; m/sec, meter per second; mm, millimeters; m^2, square meters; FS, fixed site; SYN, synoptic site; N/A, data not available]

Site name	Site number (fig. 1)	Site type	Basin area (km^2)	Land use percentage		Reach length (m)	Mean depth (m)	Mean velocity (m/sec)	Modal dominant substrate	Modal embeddedness (percent)	Mean pebble class (mm)
				Forest	Agriculture						
Black River near Lesterville, Mo.	29	FS	1,242	93	6	319	0.638	0.778	Cobble	6–25	Very coarse gravel (41)
Huzzah Creek near Scotia, Mo.	38	SYN	1,258	87	12	270	.693	.374	Cobble/Sand/ Gravel	6–25	N/A
Big River near Richwoods, Mo.	39	SYN	1,904	64	31	322	.722	.230	Gravel	51–75	N/A

Site name	Site number (fig. 1)	Mean wetted channel width (m)	Mean bank width (m)	Mean canopy angle (degrees)	Riparian quarter point vegetation (woody)			
					Mean point to plant distance (m)	Mean area per plant (m^2)	Total density (individuals per 100 m^2)	Number of species
Black River near Lesterville, Mo.	29	29.8	4.6	111	4.25	18.08	5.53	17
Huzzah Creek near Scotia, Mo.	38	23.2	N/A	77	4.31	18.58	5.38	9
Big River near Richwoods, Mo.	39	48.8	N/A	89	3.81	14.54	6.87	10

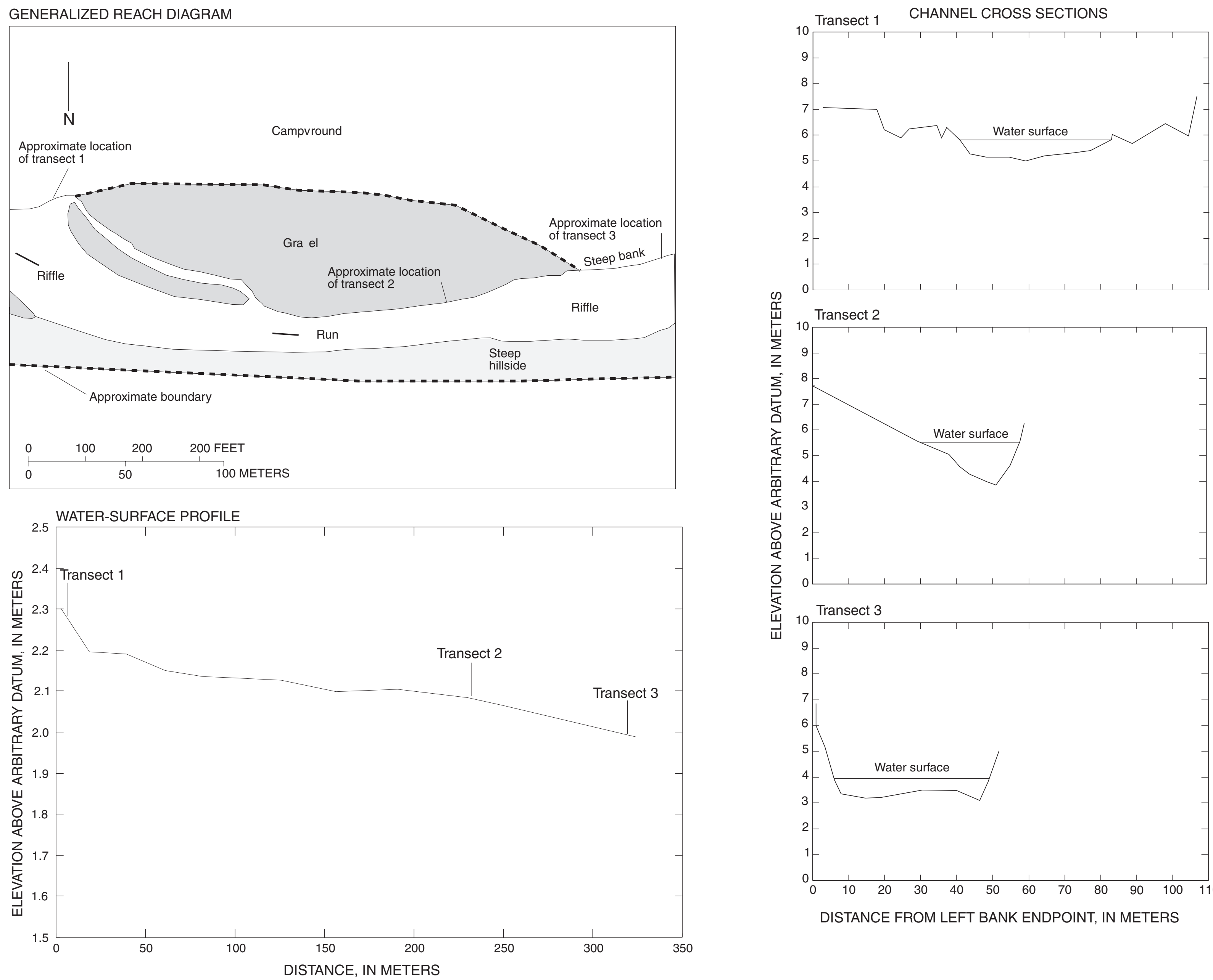

Figure 7. Generalized reach diagram, water-surface profile, and channel cross sections of the Black River near Lesterville, Missouri (station number 07061400).

Table 7. Basin and segment characteristics of fixed sites in the Salem Plateau physiographic section

[km^2, square kilometers; km, kilometers; m, meters; m/100m, meter per 100 meters; m/300m, meters per 300 meters]

Site name	Site number (fig. 1)	Basin area (km^2)	Land use percentage		Stream order	Stream length (km)	Basin relief (m)	Segment gradient (m/100m)	Sideslope gradient (m/300m)	Channel sinuosity
			Forest	Agriculture						
Forested land use										
Jacks Fork above Alley Spring, Mo.	24	790	78	22	5	80.4	282	0.223	13.2	1.36
Paddy Creek above Slabtown Spring, Mo.	31	79.0	90	10	2	15.7	177	.420	36.8	1.08
Agricultural land use										
Dousinbury Creek near Wall Street, Mo.	33	106	40	60	3	23.1	120	0.770	11.7	1.23
Niangua River at Windyville, Mo.	36	875	42	53	5	83.5	200	.410	24.9	1.90
Mixed land use										
Black River near Lesterville, Mo.	29	1,242	93	6	5	58.0	320	0.429	10.1	1.51

Table 8. Habitat data for forested sites in large drainage basins in the Springfield Plateau physiographic section

[km^2, square kilometers; m, meters; m/sec, meter per second; mm, millimeters; m^2, square meters; FS, fixed site; SYN, synoptic site; N/A, data not available]

Site name	Site number (fig. 1)	Site type	Basin area (km^2)	Land use percentage		Reach length (m)	Mean depth (m)	Mean velocity (m/sec)	Modal dominant substrate	Modal embeddedness (percent)	Mean pebble class (mm)
				Forest	Agriculture						
Buffalo River near St. Joe, Ark.	8	FS	2,147	86	13	650	0.823	0.334	Cobble	6–25	Coarse gravel (32)
Buffalo River near Eula, Ark.	6	SYN	1,562	88	12	255	.589	.316	Cobble	6–25	N/A

Site name	Site number (fig. 1)	Mean wetted channel width (m)	Mean bank width (m)	Mean canopy angle (degrees)	Riparian quarter point vegetation (woody)			
					Mean point to plant distance (m)	Mean area per plant (m^2)	Total density (individuals per 100 m^2)	Number of species
Buffalo River near St. Joe, Ark.	8	24.6	5.7	106	6.02	36.27	2.76	8
Buffalo River near Eula, Ark.	6	14.2	N/A	148	16.02	256.72	.39	6

of the channel and the left bank bar is forested (fig. 8). The channel at the Eula site is bordered by wide gravel bars on each side with Ward's Willow (*Salix caroliniana*) interspersed throughout.

Forested Land Use—Small Basins

The basin areas of the sites range from 100 to 232 km^2 (table 9). The dominant streambed substrate is cobble with an embeddedness of 6 to 25 percent. The mean pebble class at the North Sylamore Creek site is very coarse gravel with occasional bedrock outcrops. The mean wetted channel widths of the sites range from 7.7 to 11.4 m (table 9). Canopy angles range from 60 to 80 degrees. The mean quarter point to plant distances range from 2.11 to 3.94 m. The mean quarter point area per plant ranges from 4.44 to 15.52 m^2. The North Sylamore Creek site (fig. 9) has the greatest plant density and species richness of the four sites in this class.

Agricultural Land Use—Large Basins

Basin areas of the five sites surveyed range from 666 to 2,484 km^2 (table 10). The dominant streambed substrate ranged from sand to cobble. Three of five sites have a dominant streambed substrate of cobble. Embeddedness ranges from 6 to 75 percent, though for most sites it ranges from 6 to 50 percent. The mean pebble class for sites on the Illinois and Elk Rivers (figs. 10, 11) is very coarse gravel. The mean wetted channel widths range from 10.7 to 60.8 m. The canopy angles for sites on the Illinois and Elk Rivers are larger than the canopy angles at the three smaller basin (also smaller channel widths) sites. The canopy angles at the larger sites range from 121 to 128 degrees. The canopy angles at the smaller sites range from 67 to 97 degrees. These angles indicate a fairly well-lit channel for this classification of stream. The mean point to plant distance ranges from 2.00 to 6.03 m, and the mean quarter point area per plant ranges from 4.00 to 36.37 m^2. Total plant density ranges from 2.75 to 25.0 individuals per 100 m^2. The site with the most dense woody vegetation is the Elk River near Tiff City. It has a densely wooded riparian corridor on both sides of the stream.

Agricultural Land Use—Small Basins

Basin areas range from 61.1 to 137 km^2 (table 11). The dominant streambed substrate is cobble with embeddedness ranging from 6 to 50 percent. The mean pebble class of Yocum Creek is coarse gravel. The mean wetted channel widths range from 5.4 to 13.0 m (fig. 12). Peacheater Creek has the smallest basin area and mean channel width of the sites surveyed in this class. The other three sites are fairly similar in basin size and mean channel widths. The canopy angles range from 35 to 117 degrees. North Fork Indian Creek has the smallest canopy angle (35 degrees). The other three sites have canopy angles that range from 91 to 117 degrees and are considered to have an open canopy over the wetted channel. The quarter point vegetation survey indicated that the four sites have similar vegetation along their riparian corridors. Yocum Creek, a fixed site, has open pasture on one bank and a steep wooded hillside on the other (fig. 12). The mean point to plant distances range from 4.29 to 5.75 m and the mean area per plant ranges from 18.4 to 33.1 m^2. The total density of the woody vegetation ranges from 3.02 to 5.43 individuals per 100 m^2.

Mixed Land Use—Large Basins

Several of the sites surveyed did not fit well with the general classification used in this report. The Kings River flows through three physiographic sections—31 percent of the basin is in the Salem Plateau, 32 percent in the Springfield Plateau, and 37 percent in the Boston Mountains—and the basin encompasses a range of land uses. Although the predominant land use in the basins of Center Creek and the James River is agriculture, other land uses should be noted—urban and mining.

The Kings River near Berryville site (fig. 13) has a basin area of 1,365 km^2 (table 12). The dominant streambed substrate is cobble with 6 to 25 percent embeddedness. The mean pebble class is coarse gravel. The mean wetted channel width is 28.2 m. The mean canopy angle is 95 degrees. From the quarter point vegetation survey, the mean point to plant distance is 3.42 m and the mean area per plant is 11.70 m^2. The total plant density is 8.55 individuals per 100 m^2.

Center Creek near Smithfield site (fig. 14) has a basin area of 761 km^2 (table 12). The land use predominantly is agricultural with mining and urban contributions. The dominant streambed substrate is cobble that is 26 to 50 percent embedded. The mean pebble class is very coarse gravel. The mean wetted channel width is 20.2 m with a mean canopy angle of 109 degrees. The riparian corridor is wooded and has a

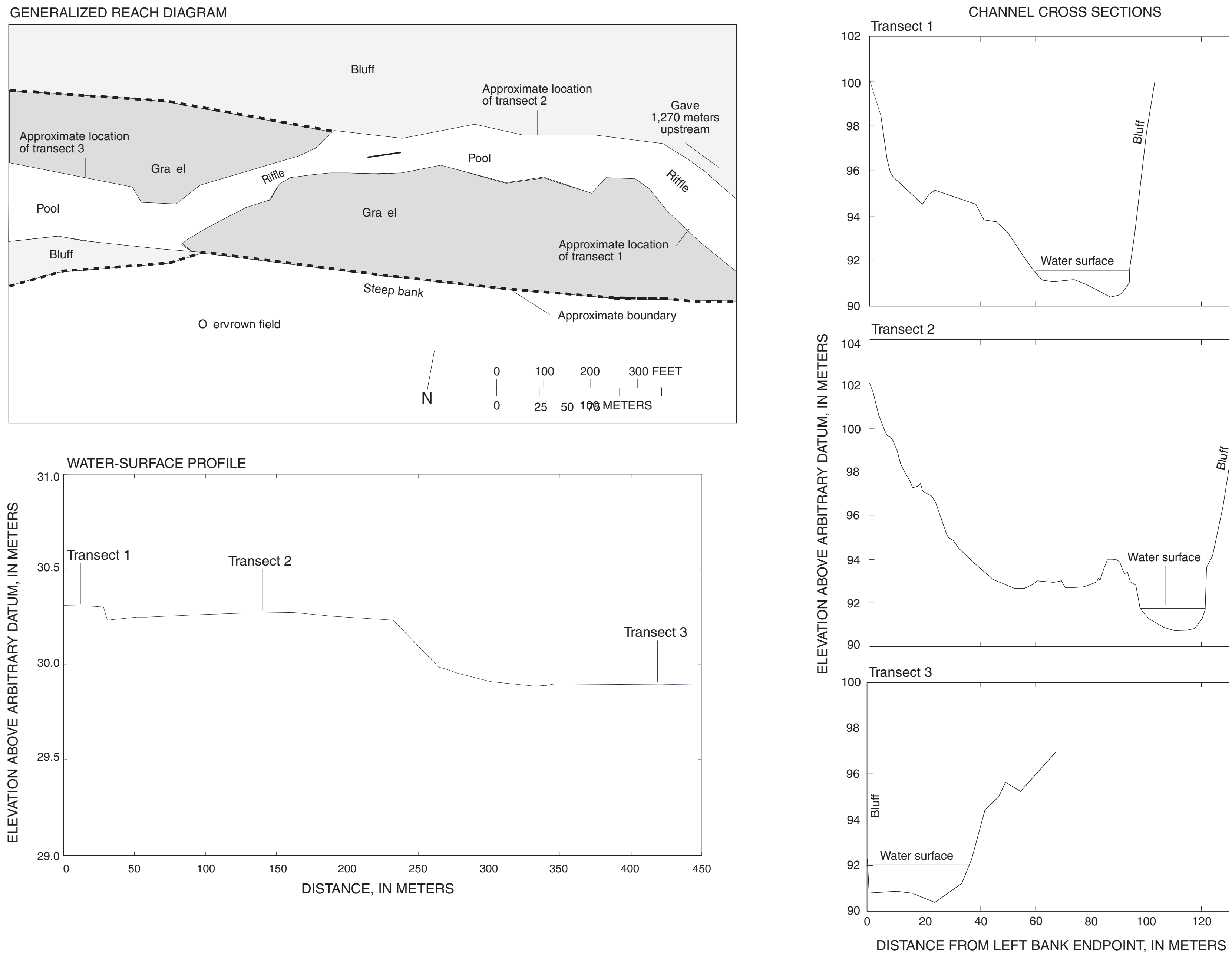

Figure 8. Generalized reach diagram, water-surface profile, and channel cross sections of the Buffalo River near St. Joe, Arkansas (station number 07056000).

Table 9. Habitat data for forested sites in small drainage basins in the Springfield Plateau physiographic section

[km^2, square kilometers; m, meters; m/sec, meter per second; mm, millimeters; m^2, square meters; FS, fixed site; SYN, synoptic site; N/A, data not available]

Site name	Site number (fig. 1)	Site type	Basin area (km^2)	Land use percentage: Forest	Land use percentage: Agriculture	Reach length (m)	Mean depth (m)	Mean velocity (m/sec)	Modal dominant substrate	Modal embeddedness (percent)	Mean pebble class (mm)
North Sylamore Creek near Fifty Six, Ark.	9	FS	150	97	3	213	0.320	0.287	Cobble	6–25	Very coarse gravel (46)
Big Creek near Big Flat, Ark.	7	SYN	232	64	36	333	.281	.522	Cobble	6–25	N/A
Water Creek near Evening Star, Ark.	10	SYN	100	72	28	221	.183	.153	Cobble/ Boulder	6–25	N/A
Mikes Creek at Powell, Mo.	16	SYN	167	72	28	224	.559	.123	Gravel	6–25	N/A

Site name	Site number (fig. 1)	Mean wetted channel width (m)	Mean bank width (m)	Mean canopy angle (degrees)	Riparian quarter point vegetation (woody): Mean point to plant distance (m)	Riparian quarter point vegetation (woody): Mean area per plant (m^2)	Riparian quarter point vegetation (woody): Total density (individuals per 100 m^2)	Riparian quarter point vegetation (woody): Number of species
North Sylamore Creek near Fifty Six, Ark.	9	9.1	5.2	80	2.11	4.44	22.5	16
Big Creek near Big Flat, Ark.	7	8.6	N/A	70	3.94	15.52	6.44	15
Water Creek near Evening Star, Ark.	10	7.7	N/A	68	3.89	15.15	6.60	12
Mikes Creek at Powell, Mo.	16	11.4	N/A	60	3.37	11.34	8.82	10

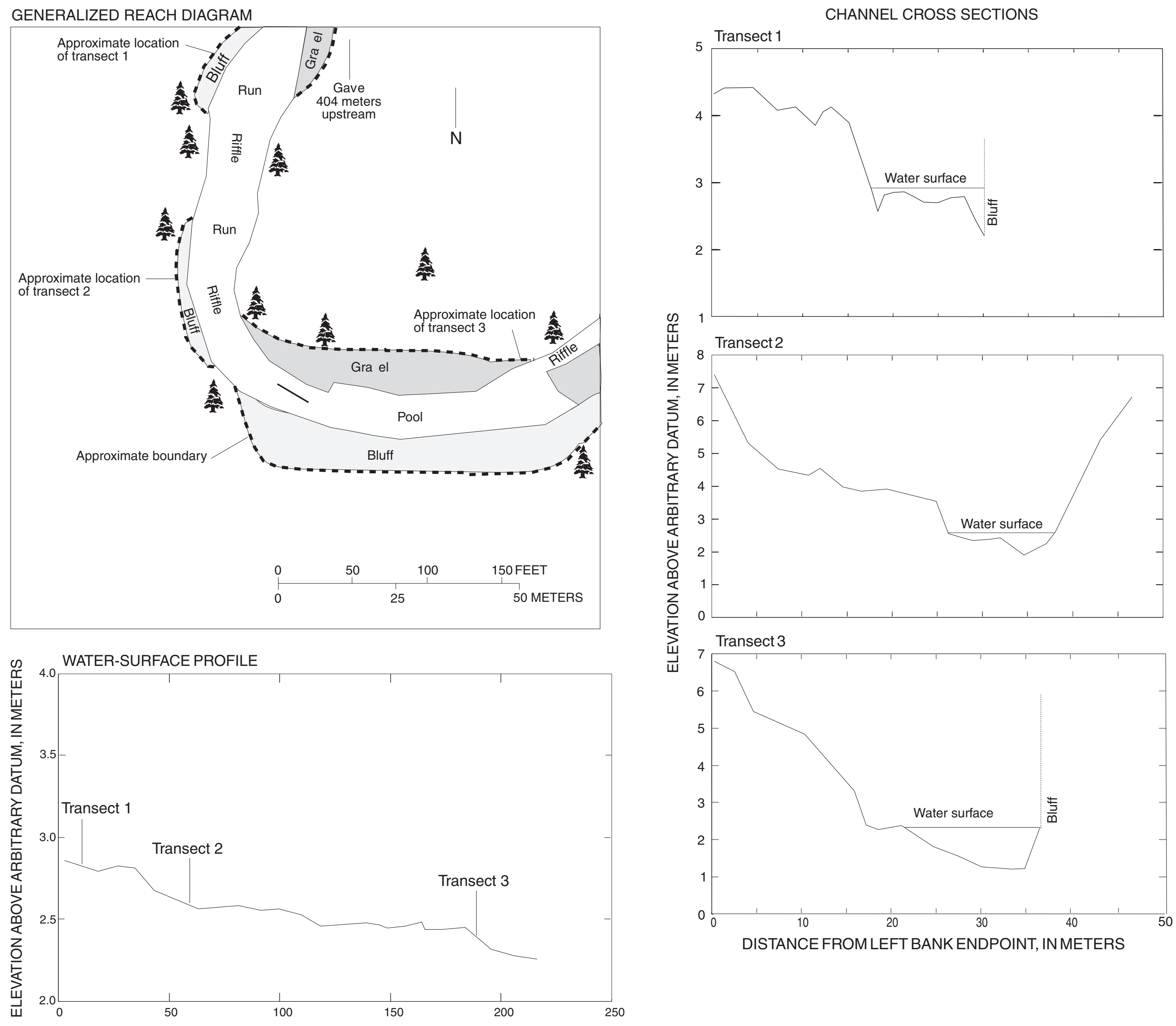

Figure 9. Generalized reach diagram, water-surface profile, and channel cross sections of North Sylamore Creek near Fifty Six, Arkansas (station number 07060710).

Table 10. Habitat data for agricultural sites in large drainage basins in the Springfield Plateau physiographic section

[km^2, square kilometers; m, meters; m/sec, meter per second; mm, millimeters; m^2, square meters; FS, fixed site; SYN, synoptic site; N/A, data not available]

Site name	Site number (fig. 1)	Site type	Basin area (km^2)	Land use percentage: Forest	Land use percentage: Agriculture	Reach length (m)	Mean depth (m)	Mean velocity (m/sec)	Modal dominant substrate	Modal embeddedness (percent)	Mean pebble class (mm)
Illinois River near Tahlequah, Okla.	3	FS	2,484	36	59	622	.696	.523	Gravel	26–50	Very coarse gravel (32)
Elk River near Tiff City, Mo.	17	FS	2,258	51	47	304	0.750	0.385	Cobble	26–50	Very coarse gravel (47)
Baron Fork at Eldon, Okla.	2	SYN	808	52	46	162	.650	.294	Cobble	6–25	N/A
War Eagle Creek near Hindsville, Ark.	12	SYN	689	61	38	305	.691	.207	Sand	51–75	N/A
Sac River near Dadeville, Mo.	30	SYN	666	15	83	200	.501	.304	Cobble	6–25	N/A

Site name	Site number (fig. 1)	Mean wetted channel width (m)	Mean bank width (m)	Mean canopy angle (degrees)	Riparian quarter point vegetation (woody): Mean point to plant distance (m)	Mean area per plant (m^2)	Total density (individuals per 100 m^2)	Number of species
Illinois River near Tahlequah, Okla.	3	51.3	2.8	121	4.28	18.36	5.45	15
Elk River near Tiff City, Mo.	17	60.8	2.1	128	2.00	4.00	25.0	10
Baron Fork at Eldon, Okla.	2	15.0	N/A	90	6.03	36.37	2.75	10
War Eagle Creek near Hindsville, Ark.	12	27.3	N/A	97	4.90	24.06	4.22	7
Sac River near Dadeville, Mo.	30	10.7	N/A	67	4.28	18.36	5.45	9

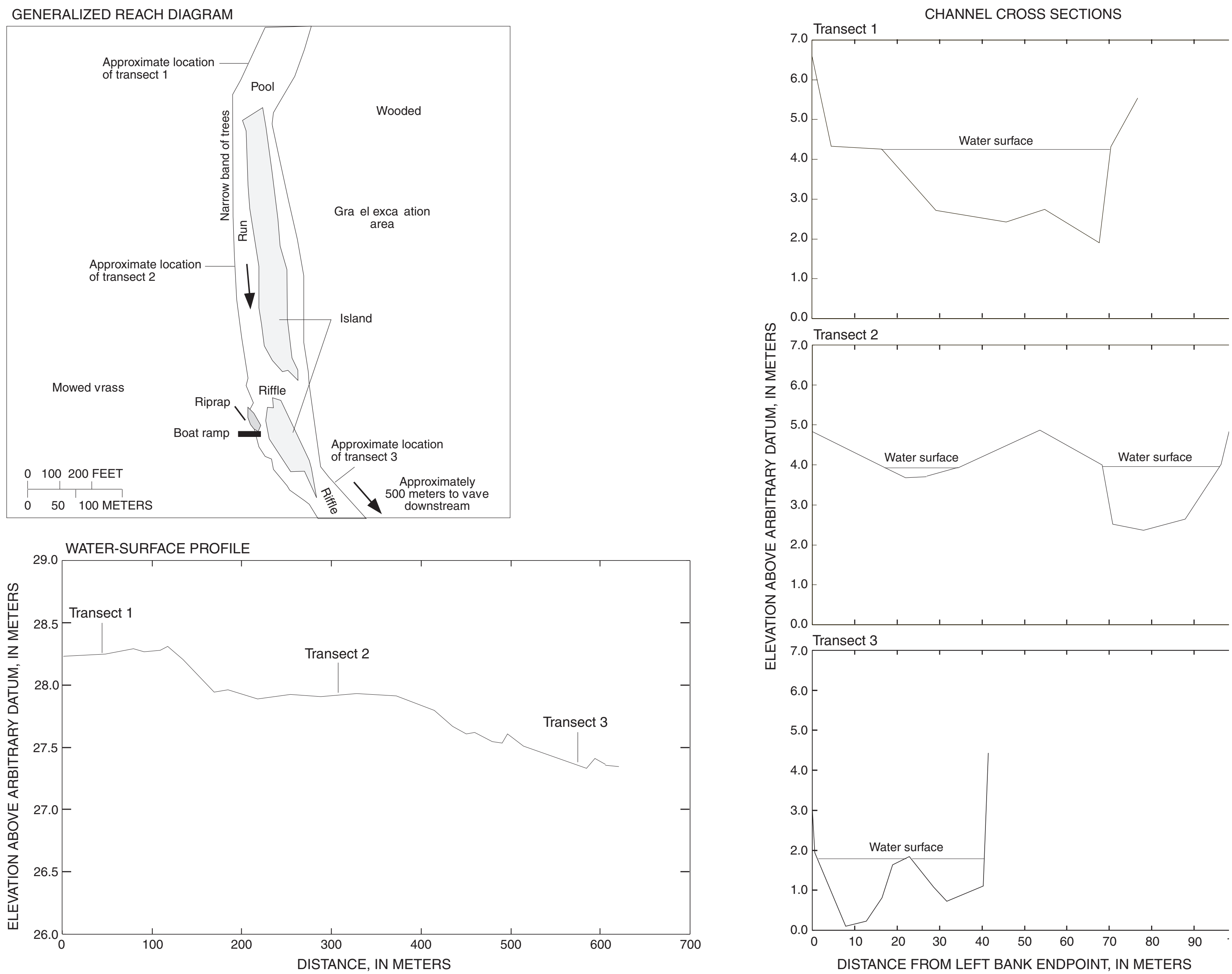

Figure 10. Generalized reach diagram, water-surface profile, and channel cross sections of the Illinois River near Tahlequah, Oklahoma (station number 07196500).

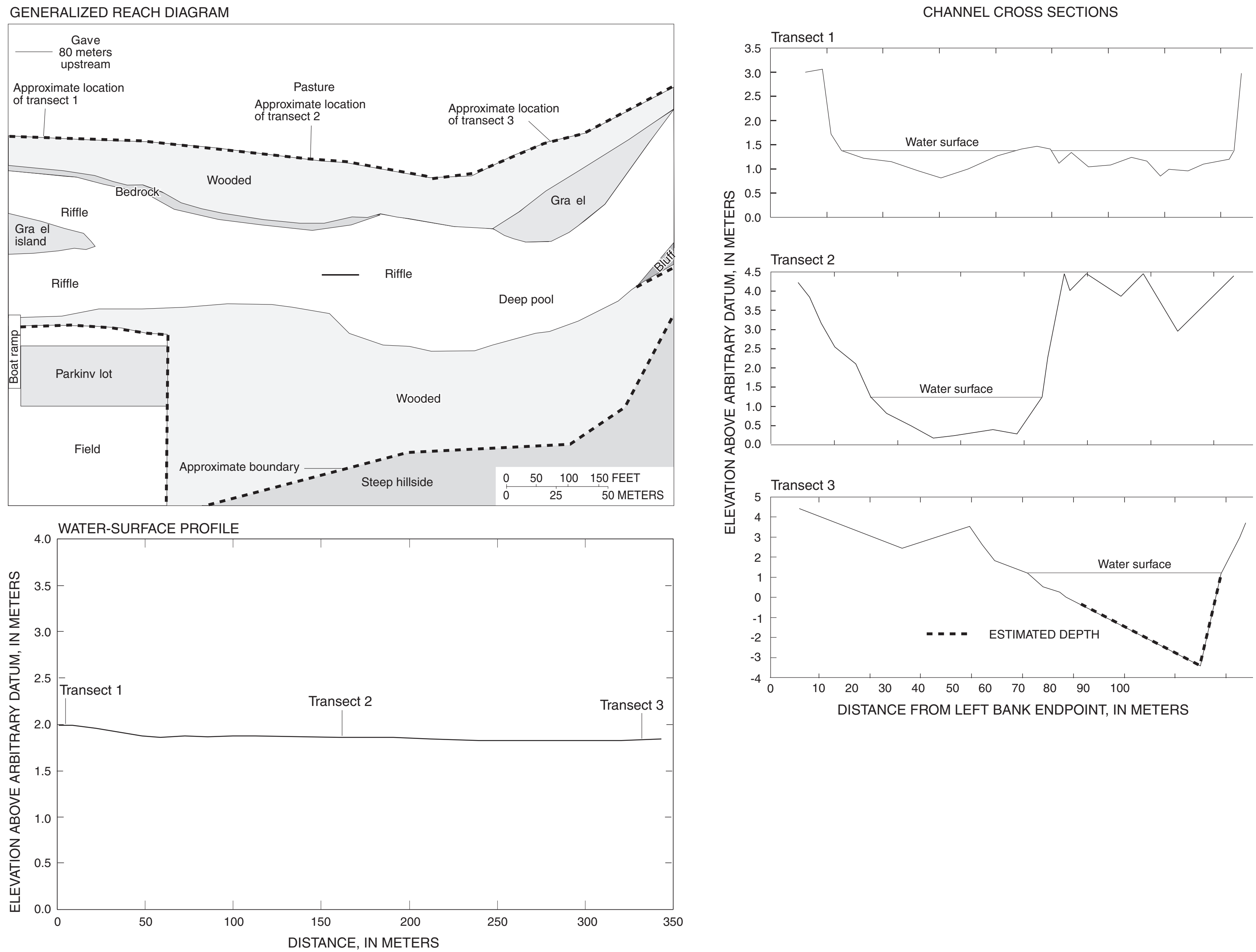

Figure 11. Generalized reach diagram, water-surface profile, and channel cross sections of the Elk River near Tiff City, Missouri (station number 07189000).

Table 11. Habitat data for agricultural sites in small drainage basins in the Springfield Plateau physiographic section

[km^2, square kilometers; m, meters; m/sec, meter per second; mm, millimeters; m^2, square meters; FS, fixed site; SYN, synoptic site; N/A, data not available]

Site name	Site number (fig. 1)	Site type	Basin area (km^2)	Land use percentage		Reach length (m)	Mean depth (m)	Mean velocity (m/sec)	Modal dominant substrate	Modal embeddedness (percent)	Mean pebble class (mm)
				Forest	Agriculture						
Yocum Creek near Oak Grove, Ark.	15	FS	137	22	76	250	0.449	0.453	Cobble	6–25	Coarse gravel (24)
Peacheater Creek at Christie, Okla.	5	SYN	61.1	42	57	164	.347	.193	Gravel	26–50	N/A
Little Osage Creek at Healing Springs, Ark.	13	SYN	102	6	91	315	.467	.121	Cobble/ Bedrock	6–25	N/A
North Fork Indian Creek near Wanda, Mo.	19	SYN	121	5	94	171	.305	.219	Cobble	26–50	N/A

Site name	Site number (fig. 1)	Mean wetted channel width (m)	Mean bank width (m)	Mean canopy angle (degrees)	Riparian quarter point vegetation (woody)			
					Mean point to plant distance (m)	Mean area per plant (m^2)	Total density (individuals per 100 m^2)	Number of species
Yocum Creek near Oak Grove, Ark.	15	13.0	2.6	91	5.57	31.0	3.22	14
Peacheater Creek at Christie, Okla.	5	5.4	N/A	103	4.96	24.6	4.06	8
Little Osage Creek at Healing Springs, Ark.	13	11.6	N/A	117	5.75	33.1	3.02	7
North Fork Indian Creek near Wanda, Mo.	19	10.4	N/A	35	4.29	18.4	5.43	13

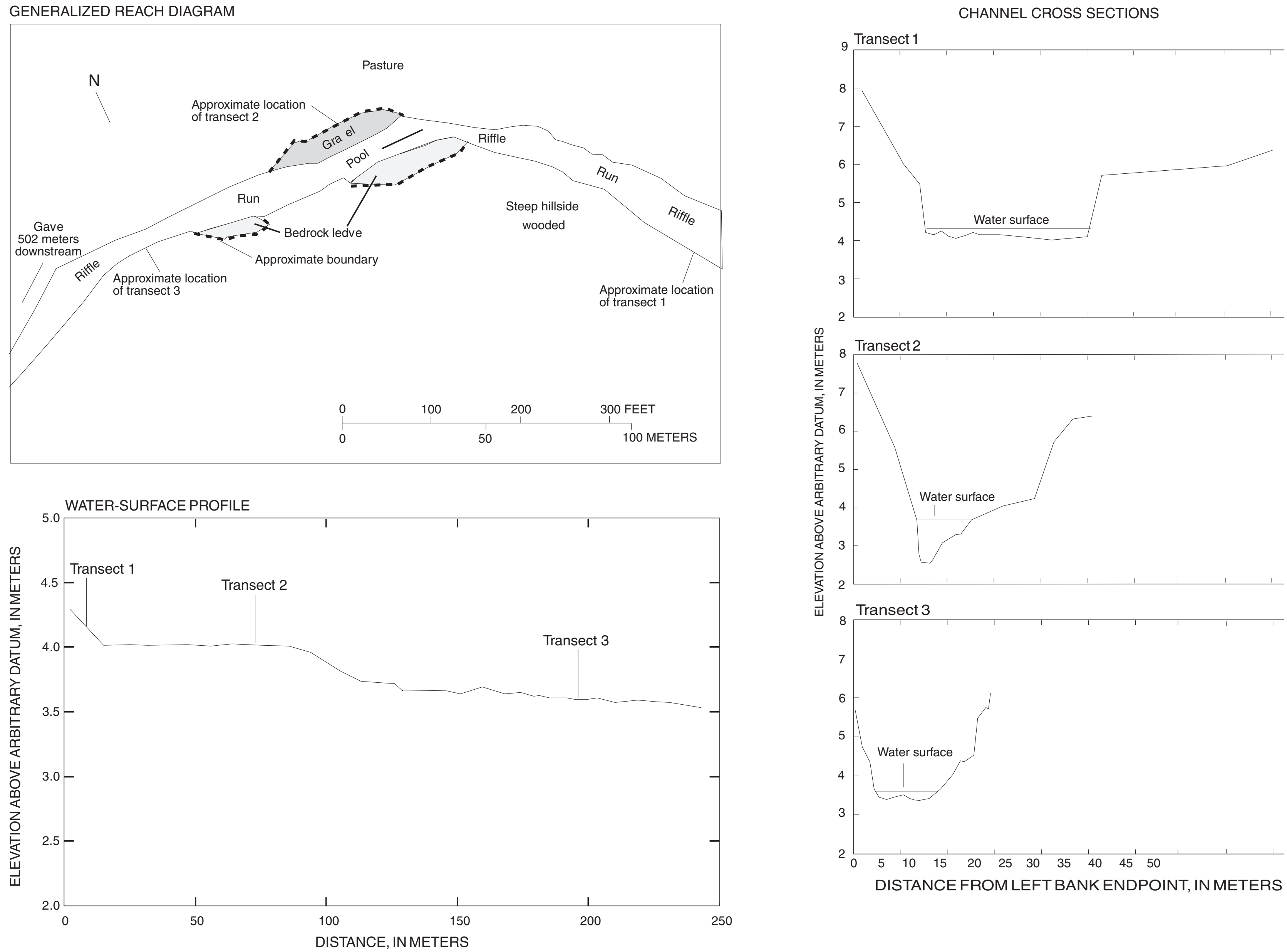

Figure 12. Generalized reach diagram, water-surface profile, and channel cross sections of Yocum Creek near Oak Grove, Arkansas (station number 07053250).

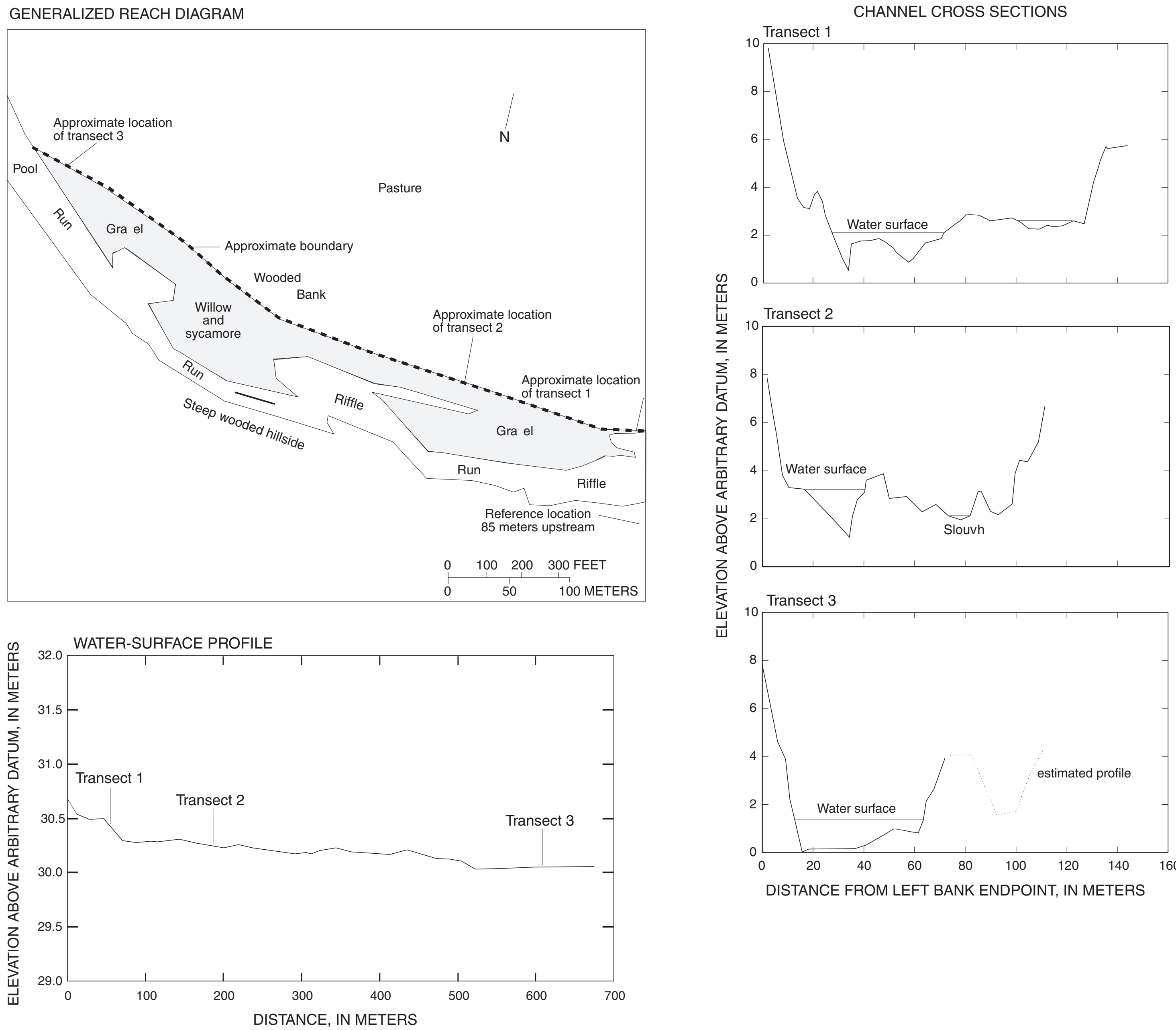

Figure 13. Generalized reach diagram, water-surface profile, and channel cross sections of the Kings River near Berryville, Arkansas (station number 07050500).

Table 12. Habitat data for sites with mixed land use in large drainage basins in the Springfield Plateau physiographic section

[km^2, square kilometers; m, meters; m/sec, meter per second; mm, millimeters; m^2, square meters; FS, fixed site; SYN, synoptic site; N/A, data not available]

Site name	Site number (fig. 1)	Site type	Basin area (km^2)	Land use percentage		Reach length (m)	Mean depth (m)	Mean velocity (m/sec)	Modal dominant substrate	Modal embeddedness (percent)	Mean pebble class (mm)
				Forest	Agriculture						
Kings River near Berryville, Ark.[1]	14	FS	1,365	68	32	550	.800	.696	Cobble	6–25	Coarse gravel (25)
Center Creek near Smithfield, Mo.	25	FS	761	17	77	213	0.522	0.602	Cobble	26–50	Very coarse gravel (42)
James River near Boaz, Mo.	22	SYN	1,202	21	68	253	.429	.446	Gravel	26–50	N/A

Site name	Site number (fig. 1)	Mean wetted channel width (m)	Mean bank width (m)	Mean canopy angle (degrees)	Riparian quarter point vegetation (woody)			
					Mean point to plant distance (m)	Mean area per plant (m^2)	Total density (individuals per 100 m^2)	Number of species
Kings River near Berryville, Ark.	14	28.2	5.5	95	3.42	11.70	8.55	13
Center Creek near Smithfield, Mo.	25	20.2	1.9	109	5.20	27.04	3.70	10
James River near Boaz, Mo.	22	49.8	N/A	104	2.71	7.34	13.63	15

[1]The Kings River actually flows through three physiographic sections; the Boston Mountains, the Springfield Plateau, and the Salem Plateau.

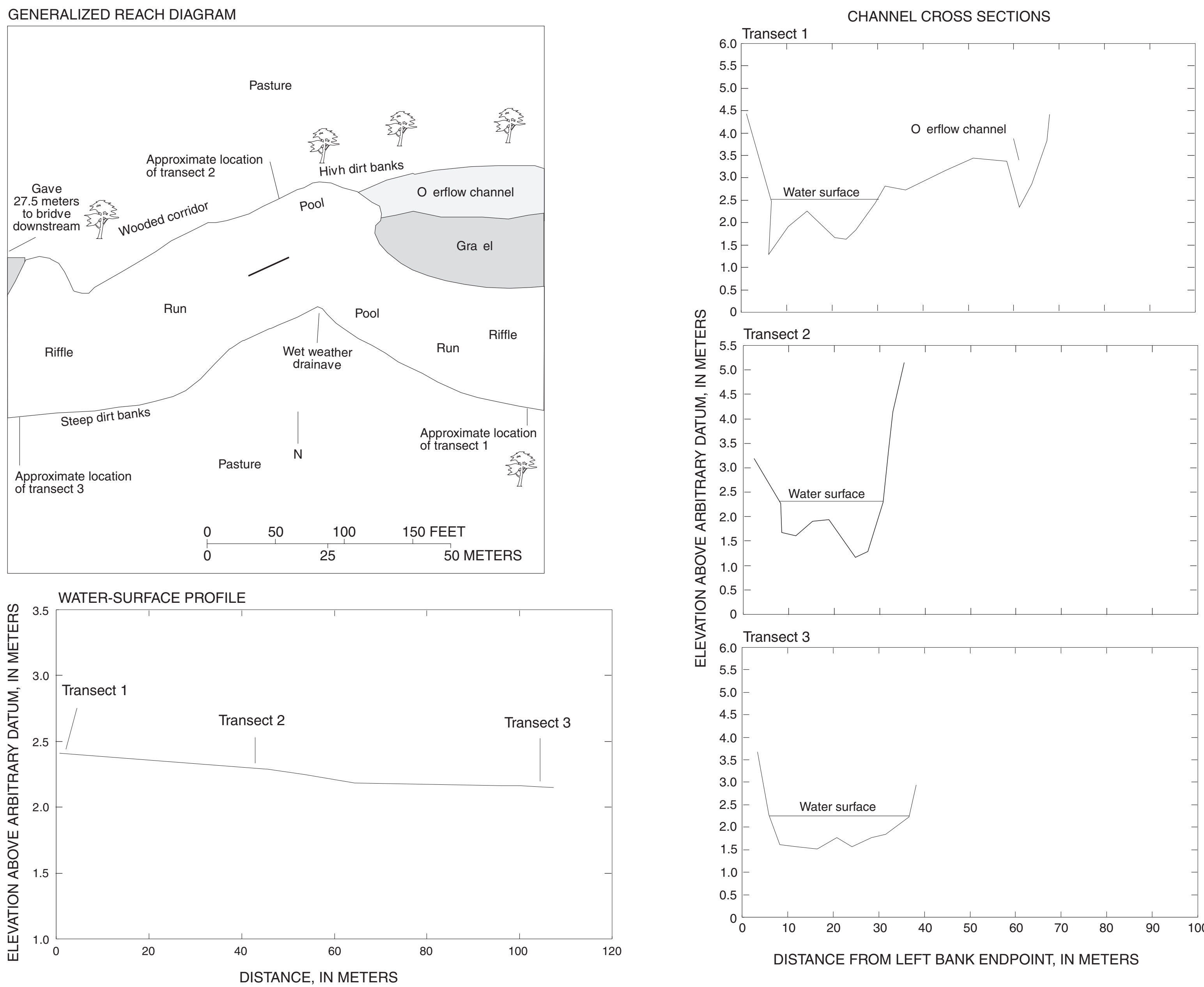

Figure 14. Generalized reach diagram, water-surface profile, and channel cross sections of Center Creek near Smithfield, Missouri (station number 07186480).

mean quarter point to plant distance of 5.20 m and a mean quarter point area per plant of 27.04 m^2. The total plant density is 3.70 individuals per 100 m^2.

The James River near Boaz site has a basin area of 1,202 km^2 (table 12). The land use predominantly is agricultural. Springfield, Missouri, the largest urban area in the study unit, is located in the James River Basin. The dominant streambed substrate is gravel (with bedrock outcrops) with an embeddedness of 26 to 50 percent. The mean wetted channel width is 49.8 m and has a mean canopy angle of 104 degrees. The riparian zone is a narrow wooded corridor that has mean quarter point to plant distance of 2.71 m, a mean quarter point area per plant value of 7.34 m^2, and a total density of 13.63 individuals per 100 m^2. The quarter point data indicate that the James River site has one of the highest woody plant species diversity of the 41 sites studied.

Comparison of Habitat Data by Basin Size and Land Use

Habitat data differed between sites of different basin size and land use. Comparison between the large and small basin sites with forest land use indicates that small basin sites tend to have steeper segment and sideslope gradients. The channel sinuosities are similar. The channel of North Sylamore Creek follows narrow undulating valley walls, which causes the channel sinuosity value to be greater than channel sinuosity values of other small streams in the Springfield Plateau physiographic section (table 13). The large basin sites tend to have deeper and swifter average flow, wider channels, larger canopy angles, and sparser vegetation than the small basin sites. The small basin sites generally have large pebble classes and greater riparian woody plant species richness. Both type of sites have similar dominant streambed substrate and embeddedness (tables 8, 9).

The small basin sites with agricultural land use generally have steeper segment and sideslope gradients than the large basin sites. The channel sinuosities are similar between the Elk River and Yocum Creek (table 13). The large basin sites generally have deeper and swifter stream flow, greater embeddedness, larger pebble class, wider channels, larger canopy angles, and larger woody plant densities than the small basin sites. The vegetation at the small basin sites have greater mean point to plant distances and mean area per plant values than the large basin sites. Both type of sites have similar woody plant species richness and dominant streambed substrates (tables 10, 11).

Sites with forested land use generally have greater basin relief, segment gradients, sideslope gradients, and sinuosities than the agricultural land-use sites (table 13). Higher sinuosity in the forested areas can be controlled by the meandering valley wall planform (R.A. McKenney, U.S. Geological Survey, oral commun., 1996). Both forested and agricultural sites have similar mean pebble classes and dominant streambed substrates. The streambed substrate is more embedded at most of the agricultural sites than in forested sites. Mean wetted channel widths are smaller in the forested sites in comparison with the agricultural sites. Mean bank widths generally are larger in the forested sites. The canopy angles are larger at the forested sites in the larger basins and smaller in the forested sites in the smaller basins in comparison with the agricultural sites. Based on the quarter point vegetation data, in the smaller basins the forested sites generally have more woody plants and greater species richness than the agricultural sites. At the sites in the larger basins, the agricultural sites tend to have more woody plants and greater woody plant species richness than the forested sites. Forested sites in the large basins have wide, open floodplains. Though the dominant land use in the basin is forest, the dominant land use in the riparian valley is pasturelands.

Boston Mountains Physiographic Section

The two sites studied in the Boston Mountains physiographic section are in small basin areas and have forest as the primary land use. Basin areas are 149 and 174 km^2 (table 14). The dominant streambed substrate at the two sites are different; cobble at the Buffalo River near Boxley (fig. 15), and boulder at Richland Creek near Witts Springs. The modal embeddedness is 26 to 50 percent at both sites. The mean pebble class at the Buffalo River is small cobble. Mean wetted channel widths are 15.9 and 27.4 m. Canopy angles are similar at these sites and they result in a shaded stream channel. The sites have high woody plant species richness, but are not heavily wooded in comparison with forested sites based on the quarter point vegetation data from this study. The Buffalo River and Richland Creek mean quarter point to plant distances are 3.54 and 6.83 m, and the mean quarter point area per plant is 12.53 and 46.68 m^2.

Table 13. Basin and segment characteristics of fixed sites in the Springfield Plateau physiographic section

[km^2, square kilometers; km, kilometers; m, meters; m/100m, meter per 100 meters; m/300m, meters per 300 meters; FS, fixed site; SYN, synoptic site]

Site name	Site number (fig. 1)	Basin area (km^2)	Land use percentage		Stream order	Stream length (km)	Basin relief (m)	Segment gradient (m/100m)	Sideslope gradient (m/300m)	Channel sinuosity
			Forest	Agriculture						
Forested land use										
Buffalo River near St. Joe, Ark.	8	2,147	86	13	6	127.5	589	0.188	80.4	1.50
North Sylamore Creek near Fifty Six, Ark.	9	150	97	3	4	23.1	263	.304	94.5	1.52
Agricultural land use										
Illinois River near Tahlequah, Okla.	3	2,484	36	59	6	156.0	338	0.108	15.2	3.00
Yocum Creek near Oak Grove, Ark.	15	137	22	76	4	27.6	260	.370	51.0	1.24
Elk River near Tiff City, Mo.	17	2,258	51	47	5	111.0	247	.062	7.6	1.23
Mixed land use										
Kings River near Berryville, Ark.	14	1,365	68	32	6	126.0	426	0.030	12.7	2.69
Center Creek near Smithfield, Mo.	25	761	17	77	5	89.5	183	.156	3.8	1.38

Table 14. Habitat data for forested sites in small drainage basins in the Boston Mountains physiographic section

[km^2, square kilometers; m, meters; m/sec, meter per second; mm, millimeters; m^2, square meters; km, kilometers; m/100m, meters per 100 meters; m/300m, meters per 300 meters; FS, fixed site; SYN, synoptic site; N/A, data not available]

Site name	Site number (fig. 1)	Site type	Drainage area (km^2)	Land use percentage		Reach length (m)	Mean depth (m)	Mean velocity (m/sec)	Modal dominant substrate	Modal embeddedness (percent)	Mean pebble class (mm)
				Forest	Agriculture						
Buffalo River near Boxley, Ark.	4	FS	149	96	4	293	0.619	0.158	Cobble	26–50	Small cobble (75)
Richland Creek near Witts Springs, Ark.	1	SYN	174	97	3	156	.327	.067	Boulder	26–50	N/A

Site name	Site number (fig. 1)	Mean wetted channel width (m)	Mean bank width (m)	Mean canopy angle (degrees)	Riparian quarter point vegetation (woody)			
					Mean point to plant distance (m)	Mean area per plant (m^2)	Total density (individuals per 100 m^2)	Number of species
Buffalo River near Boxley, Ark.	4	27.4	5.31	69	3.54	12.53	8.00	16
Richland Creek near Witts Springs, Ark.	1	15.9	N/A	63	6.83	46.68	2.14	13

Site name	Site number (fig. 1)	Stream order	Stream length (km)	Basin relief (m)	Segment gradient (m/100m)	Sideslope gradient (m/300m)	Channel sinuosity
Buffalo River near Boxley, Ark.	4	4	29.0	412	0.582	89.3	1.27
Richland Creek near Witts Springs, Ark.	1	N/A	N/A	N/A	N/A	N/A	N/A

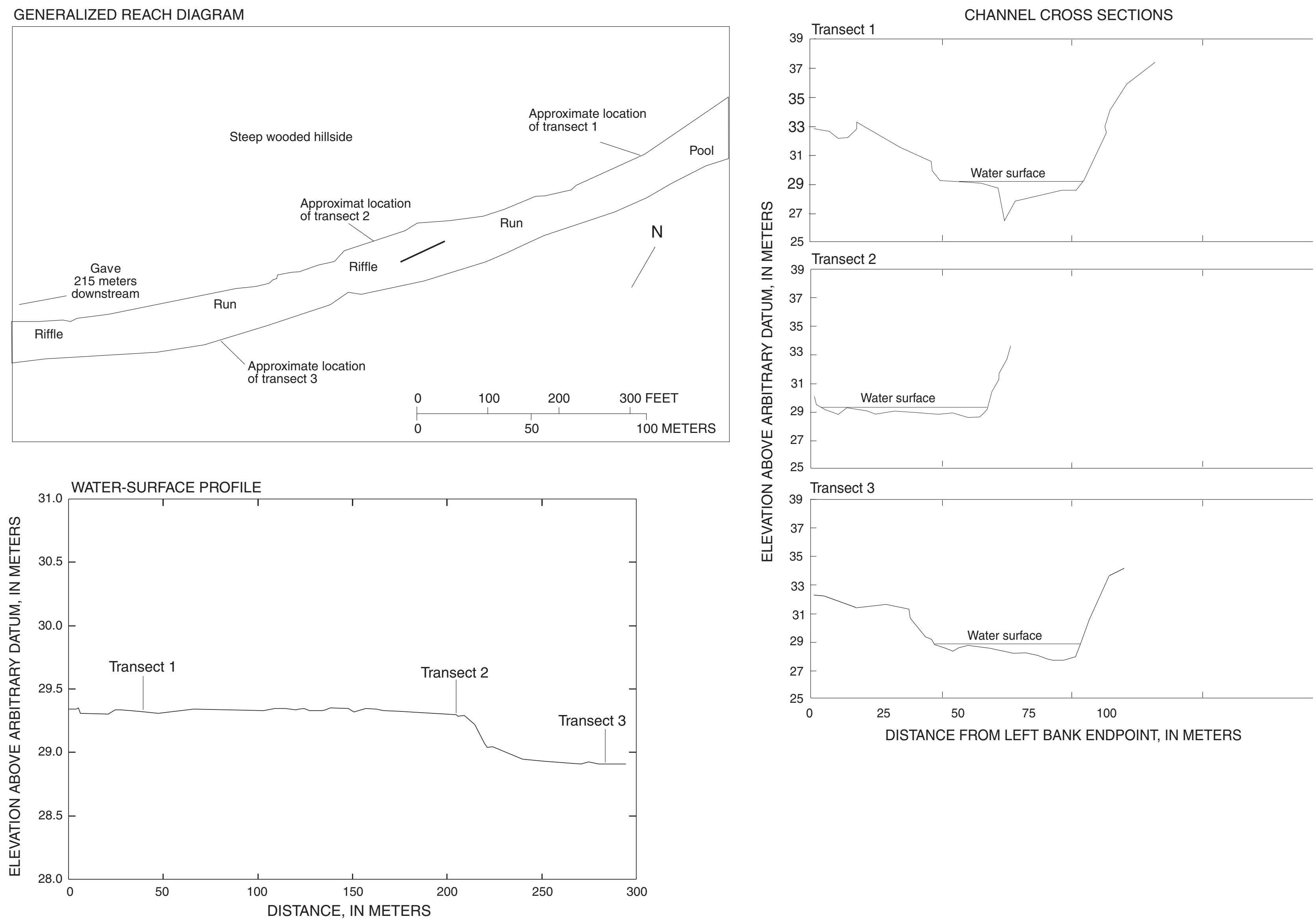

Figure 15. Generalized reach diagram, water-surface profile, and channel cross sections of the Buffalo River near Boxley, Arkansas (07055646).

HABITAT CHARACTERISTICS BY PHYSIOGRAPHIC SECTION

Salem and Springfield Plateaus—Forested Land Use

Sixteen sites were studied in the Salem and Springfield Plateaus that have forest as the primary land use. Sites are classified forested land use if 50 percent or more of the basin is forested. Four of the 16 sites are fixed sites.

Sites in the Salem and Springfield Plateaus differ in habitat data measured at the reach, segment, and basin scales. Basin areas of these sites range from 46.4 to 4,318 km^2. The mean water depths and velocities tend to be greater at sites in the Springfield Plateau physiographic section than at sites in the Salem Plateau physiographic section (table 15). The dominant streambed substrate is similar in both physiographic sections and is slightly more embedded at sites in the Salem Plateau physiographic section. Mean wetted channel widths are greater at sites in the Salem Plateau physiographic section than at sites in the Springfield Plateau physiographic section. The sites in the Springfield Plateau physiographic province generally have larger mean canopy angles and less dense woody riparian vegetation than those sites in the Salem Plateau physiographic section. The sites surveyed in the Springfield Plateau physiographic section have greater mean basin relief, sideslope gradient, and channel sinuosity than sites in the Salem Plateau physiographic section. The sites in the Salem Plateau physiographic section have steeper segment gradients than those in the Springfield Plateau physiographic section.

Large Basins

The two sampling sites in the Springfield Plateau physiographic section with forested land use (Buffalo River near St. Joe and Buffalo River near Eula) are not similar in their physical structure. This fact may skew averages for those sites in large basins in the Springfield Plateau physiographic section and be inappropriate for comparison to sites of similar size and land use in the Salem Plateau physiographic section. The basin areas for the sites range from 761 to 4,318 km^2. The sites surveyed in the two physiographic sections have similar mean basin areas and streambed substrates. The sampling reach lengths are longest in the Salem Plateau physiographic section. The sites in the Springfield Plateau physiographic section have deeper flow, narrower channel widths, larger canopy angles, less dense woody riparian vegetation, and less woody plant richness than the sites surveyed in the Salem Plateau physiographic section. Sites in the Springfield Plateau physiographic section also generally have larger stream orders, stream lengths, basin relief, sideslope gradient, channel sinuosities, and less steep segment gradients than corresponding sites in the Salem Plateau physiographic section.

Small Basins—including two sites in the Boston Mountains Physiographic Section

Sites in small basins differ in habitat characteristics measured at the reach, segment, and basin scales. Basin areas for the 10 sites range from 46.4 to 232 km^2. The sites surveyed in the Springfield Plateau and Boston Mountains physiographic sections have the largest mean basin areas and the sites in the Salem Plateau physiographic section have the smallest basin areas of the three physiographic sections studied. The Salem and Springfield Plateaus, and the Boston Mountains physiographic sections have similar sampling reach lengths (table 15). Mean water depths at the sites in the Boston Mountains physiographic section are the deepest, and the sites in the Springfield Plateau physiographic section have the swiftest mean velocities. The modal dominant streambed substrates are predominantly cobble at all sites with the substrate at the sites in the Springfield Plateau physiographic section less embedded. The mean canopy angles at the sites in the Springfield Plateau physiographic region are the largest, although all sites in the three physiographic sections have similar canopy angles. The sites in the Salem Plateau physiographic section have the most dense riparian woody vegetation. The sites in the Boston Mountains physiographic section have the most woody plant species richness and the least dense vegetation with the exception of agricultural sites in the Springfield Plateau physiographic section. The sites in the Salem Plateau physiographic section have a median stream order of 2; sites in the other physiographic sections have a median stream order of 4. The sites in the Boston Mountains physiographic section have greater basin relief and segment gradient than sites in the other physiographic sections. The sites in the Springfield Plateau physiographic region have the largest sideslope gradient and channel sinuosity. The

Table 15. Summary of habitat characteristics for each of the major physiographic sections and their primary land use and size in the Ozark Plateaus study unit

[km^2, square kilometers; m, meters; m/sec, meter per second; m^2, square meters; km, kilometers; m/100m, meter per 100 meters; m/300m, meters per 300 meters; values shown are calculated from mean/median/modal values for individual sites]

Habitat feature	Forested					Agricultural			
	Large basin		Small basin			Large basin		Small basin	
	Salem Plateau	Springfield Plateau	Salem Plateau	Springfield Plateau	Boston Mountains	Salem Plateau	Springfield Plateau	Salem Plateau	Springfield Plateau
Number of sites	**6**	**2**	**4**	**4**	**2**	**4**	**5**	**4**	**4**
Mean drainage area (km^2)	1,594	1,854	74.1	162	162	745	1,381	123	105
Median reach length (m)	594	452	213	248	224	275	319	233	225
Mean depth (m)	.579	.706	.262	.336	.473	.409	.658	.367	.392
Mean velocity (m/sec)	.535	.325	.176	.271	.112	.287	.343	.137	.246
Modal streambed substrate	Cobble	Cobble	Cobble	Cobble	Boulder/ Cobble	Cobble	Cobble	Cobble	Cobble
Median streambed substrate embeddedness (percent)	6–25	6–25	26–50	6–25	26–50	6–25	26–50	6–25	6–25
Mean wetted channel width (m)	41.0	19.4	12.1	9.2	21.6	33.0	33.0	15.0	10.1
Mean canopy angle (degrees)	97	127	51	70	66	92	101	98	86
Mean point to plant distance (m)	3.60	11.02	2.53	3.33	5.18	3.18	4.30	3.02	5.14
Mean area per woody plant (m^2)	14.74	146.5	6.86	11.61	29.60	10.47	20.23	9.64	26.78
Mean total woody plant density (individuals per 100 m^2)	9.74	1.58	19.84	11.1	5.07	11.22	8.57	8.82	3.93
Number of woody plant species (median)	11.5	7	11	13.0	14.5	11	10	9	10.5

Table 15. Summary of habitat characteristics for each of the major physiographic sections and their primary land use and size in the Ozark Plateaus study unit—Continued

	Forested					Agricultural			
	Large basin		Small basin			Large basin		Small basin	
Habitat feature	**Salem Plateau**	**Springfield Plateau**	**Salem Plateau**	**Springfield Plateau**	**Boston Mountains**	**Salem Plateau**	**Springfield Plateau**	**Salem Plateau**	**Springfield Plateau**
Number of sites	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1**
Stream order (Strahler)	5	6	2	4	4	5	5.5 (median)	3	4
Stream length (km)	80.4	127.5	15.7	23.1	29.0	83.5	133.5 (mean)	23.1	27.6
Basin relief (m)	282	589	177	263	412	200	292 (mean)	120	260
Segment gradient (m/100m)	.223	.188	.420	.304	.582	.410	.085 (mean)	.770	.370
Mean sideslope gradient (m/300m)	13.2	80.4	36.8	94.5	89.3	24.9	11.4	11.7	51.0
Channel sinuosity	1.36	1.50	1.08	1.52	1.27	1.90	2.11 (mean)	1.23	1.24

forested sites in the Salem Plateau physiographic section have sinuosities of a nearly straight channel.

Salem and Springfield Plateaus—Agricultural Land Use

Instream and riparian habitat characteristics were studied at 17 sites in areas where the primary land use is agriculture. Five of these sites were fixed sites.

Sites with predominantly agricultural land use in the Salem and Springfield Plateaus physiographic sections differ in habitat characteristics measured at the reach, segment, and basin scales (table 15). Basin areas for sites located in basins of predominantly agricultural land use range from 61.1 to 2,484 km^2. Sampling reach lengths are similar between physiographic sections. The large basin sites have longer sampling reach lengths than the small basin sites. The sites in the Springfield Plateau physiographic section tend to have greater mean stream depths and velocities, point to plant distances, area per plant, basin relief, and channel sinuosities than sites in the Salem Plateau physiographic section. Sites in the Salem Plateau physiographic section generally have greater total plant densities and segment gradients than those in the Springfield Plateau physiographic section. Similarities between the agricultural sites in both physiographic sections are streambed substrate, embeddedness, and number of woody plant species.

Large Basins

Agricultural sites in large basins differ in their habitat characteristics by physiographic section. Sites surveyed in the Springfield Plateau physiographic section generally have greater basin areas and reach lengths than those in the Salem Plateau physiographic section. Sites located in the Springfield Plateau physiographic section generally have deeper and swifter flow, less dense woody vegetation, greater stream lengths, basin relief, and channel sinuosities than the sites in the Salem Plateau physiographic section. Sites in the Salem Plateau physiographic section have steeper segment and sideslope gradients. The sites studied have similar streambed substrate, though it is slightly more embedded at sites in the Springfield Plateau physiographic section. The sites also have comparable stream order and canopy angles.

Small Basins

The habitat characteristics of sites in small basins with predominantly agricultural land use differ by physiographic section. The agricultural sites in small basins in the Springfield Plateau physiographic section have smaller basin areas and similar reach lengths in comparison to sites in the Salem Plateau physiographic section. The mean stream depths, streambed substrate, and embeddedness are similar in both physiographic sections; however, the mean velocity generally is greater at sites in the Springfield Plateau physiographic section. Channel widths are greater and the canopy angles are slightly larger at the sites in the Salem Plateau physiographic section. Woody vegetation is less dense at the sites in the Springfield Plateau physiographic section, but they generally have slightly greater species richness than sites in the Salem Plateau physiographic section. The sites in the Springfield Plateau physiographic section have larger stream orders, stream lengths, basin relief, and sideslope gradients than sites in the Salem Plateau physiographic section.

HABITAT DATA BY LAND USE AND BASIN SIZE

The canopy angles at agricultural sites in large and small basins are similar and the large basin sites at agricultural and forested sites are similar, but canopy angles at sites with small basins of either land use are not similar to those sites with large basins. The woody riparian vegetation density is greater at forested sites and at small sites, greatest at small basin forested sites, and least at large basin forested sites. The mean stream depth is larger at large basin sites than at small basin sites. Mean velocities are similar among small basin sites and dissimilar among the large and small basin sites and different land use. There are substantial differences in channel widths between the forested and agricultural land use in the small basin sites, although the channel widths are similar between land uses in the large basin sites. The channel widths are larger at sites in large basins compared to their counterparts in small basin sites. Basin relief is greater at large basin sites or in forested land use, or both, than at sites in small basin sites or agricultural land use, or both. The segment gradients are similar among land uses, but differ in respect to basin size. Small basin sites have greater segment gradients than large basin sites. Sideslope

gradients differ between sites with respect to basin size and by land use. The sideslope gradients are greater at small basin sites with forested land use. Channel sinuosities generally are larger at sites with agricultural land use. North Sylamore Creek near Fifty Six has a large sinuosity for a forested site.

SUMMARY

Data for 41 sites surveyed during 1993 through 1995 in the Ozark Plateaus study unit of the National Water-Quality Assessment Program were analyzed for this report. These sites are located in three major physiographic sections (Salem Plateau, Springfield Plateau, and Boston Mountains), in areas of dominant land use (mostly forested and agricultural), and in large (greater than 500 square kilometers) and small (less than 300 square kilometers) basins. Some sites in mixed and mining land use were partially analyzed regarding their respective physiographic section. Overall, 21 sites in the Salem Plateau physiographic section, 18 sites in the Springfield Plateau physiographic section, and 2 sites in the Boston Mountains physiographic section were surveyed. For land use, 18 sites in forested areas, 17 sites in agricultural areas, 3 sites in mixed and urban areas, and 4 sites in areas affected by mining were surveyed.

Data from onsite measurements, such as longitudinal and transverse profiles, canopy angles, streambed substrate, and vegetation, were augmented by information such as basin relief, segment gradient, channel sinuosity, and stream order. This information was obtained from 7.5 minute and 1:100,000 topographic maps.

Habitat characteristics show appreciable differences between sites of differing physiographic sections and land use. Basin areas for the sites surveyed range from 46.4 to 4,318 square kilometers. The median stream orders range from 2 to 6 (small basin sites, 2 to 4; large basin sites, 5 to 6). Basin relief is greatest in the Boston Mountains and the least in the Salem Plateau physiographic section. Streams at all sites studied are classified as pool/riffle.

The segment gradient is largest for sites in the Boston Mountains physiographic section and least for sites in the Springfield Plateau physiographic section. The sideslope gradient is greatest for sites in the Boston Mountains physiographic section and the least for sites in the Salem Plateau physiographic section except for agricultural sites in large basins in which those sites in the Salem Plateau physiographic section have a gradient greater than the comparable sites in the Springfield Plateau physiographic section. Channel sinuosities tend to be greatest for sites in the Springfield Plateau physiographic section and the least for sites in the Boston Mountains physiographic section.

The mean water depths are greatest at the sites in the Springfield Plateau physiographic section and the least at the sites in the Salem Plateau physiographic section. Mean velocities are greatest at sites in the Springfield Plateau physiographic section and the least at sites in the Boston Mountains physiographic section. Cobble is the dominant streambed substrate at most of the sites studied, and the embeddedness of the substrate tends to be less than 50 percent.

The canopy angles generally are greatest at sites in the Springfield Plateau physiographic section and the least at sites in the Boston Mountains physiographic section. The canopy angles are largest at large basin sites and at small basin sites with agricultural land use. The two sites surveyed with forested land use in large basins in the Springfield Plateau physiographic section do not have similar habitat characteristics, especially in respect to the riparian vegetation. Although the major land use in these basins is forested, the land use in the floodplains is remnants of pasturelands. The total density of the riparian woody vegetation generally is largest at sites in the Salem Plateau physiographic section and smallest at sites in the Boston Mountains physiographic section. Sites in the Boston Mountains physiographic section have the greatest woody plant species richness of all the sites surveyed.

Large basin sites generally have greater values for the habitat characteristics (depth, velocity, and channel width, for example) surveyed than small basin sites. Some exceptions are the segment and sideslope gradients, which generally are larger at the small basin sites than at large basin sites. Total woody riparian plant densities at large basin sites with predominantly agricultural land use are larger than densities at agricultural sites in small basins, and the total woody riparian plant densities at forested sites in small basins are larger than at forested sites in large basins.

When comparing data sorted by primary land-use type, the sites with forested land use tend to have steeper basin relief and sideslope gradients than sites with agricultural land use. The woody riparian vegetation at the forested sites is substantially more dense (small basins) and has greater species richness than the

agricultural sites. The agricultural sites studied have larger canopy angles, segment gradients, and channel sinuosities than the forested sites.

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